

Final

**Record of Decision for
Surface Media at
MSFC-002/087: Inactive Abandoned Drum Disposal
Site/Inactive Cyanide Lagoon
Operable Unit 18**

**Redstone Arsenal
Madison County, Alabama
U.S. EPA ID No. AL7 210 020 742**

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List of Acronyms

ADEM	Alabama Department of Environmental Management
Army	U.S. Army Garrison – Redstone
bgs	below ground surface
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSM	conceptual site model
DAF ₄	dilution attenuation factor 4
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
EPA	U.S. Environmental Protection Agency
ESMP	endangered species management plan
HI	hazard index
HQ	hazard quotient
IROD	Interim Record of Decision
IRP	Installation Restoration Program
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
MSFC	George C. Marshall Space Flight Center
MSFC-002/087	Inactive Abandoned Drum Disposal Site/Inactive Cyanide Lagoon
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NFA	No Further Action
NTCRA	non-time-critical removal action
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PP	Proposed Plan
PRG	preliminary remediation goal

List of Acronyms (Continued)

RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	remedial investigation
ROD	Record of Decision
Rust	Rust Environment & Infrastructure, Inc.
SAC	site access control
SB	Statement of Basis
Shaw	Shaw Environmental, Inc.
SI	site investigation
SLERA	screening-level ecological risk assessment
SSL	soil screening level
TCE	trichloroethene
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound

1.0 The Declaration

1.1 Site Name and Location

Inactive Abandoned Drum Disposal Site/Inactive Cyanide Lagoon (MSFC-002/087)
Operable Unit (OU) 18
Redstone Arsenal
Madison County, Alabama

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
Identification Number: AL7 210 020 742

U.S. Army Garrison – Redstone (Army)

1.2 Statement of Basis and Purpose

This Record of Decision (ROD) presents the Selected Remedy of No Further Action (NFA) for the surface media (defined as surface soil, subsurface soil, surface water, sediment, spring water, and soil vapor) at MSFC-002/087 at Redstone Arsenal in Madison County, Alabama. The remedy was chosen in accordance with CERCLA as amended by the Superfund Amendments and Reauthorization Act of 1986, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations Part 300. The remedy was also chosen to be in compliance with the Resource Conservation and Recovery Act (RCRA).

The remedy selection was based on information contained in the Administrative Record file for this site, which has been developed in accordance with Section 113 (k) of CERCLA and which is available for review at the information repository locations presented in Section 2.3 of this ROD. The final remedy selection is also based on the completed non-time-critical removal action (NTCRA) conducted by the Army to address elevated concentrations of pesticides and polynuclear aromatic hydrocarbons (PAH) in soil.

The Army and the U.S. Environmental Protection Agency (EPA) have selected the final remedy of NFA for MSFC-002/087. The Alabama Department of Environmental Management (ADEM) concurs with the Selected Remedy.

A glossary of terms used in this ROD is presented in Appendix A.

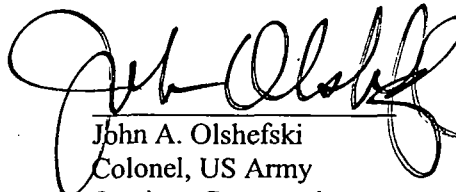
1.3 Description of the Selected Remedy

The Army and EPA, with concurrence from ADEM, have determined that an NFA remedy is required for surface media at MSFC-002/087 to ensure protection of human health and the environment. Although no chemicals of concern (COC) were detected in groundwater under MSFC-002/087, groundwater is not part of the scope of this ROD. Any further groundwater investigation/cleanup under MSFC-002/087 will proceed under a broader watershed approach (i.e., RSA-149 groundwater site).

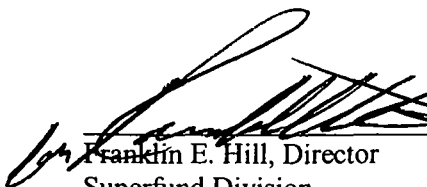
1.4 Statutory Determinations

An NTCRA for soil at MSFC-002/087 (OU-18) has eliminated the need for further remedial action at the site. The measured level of risk to human health and the environment following the removal action allows for unrestricted use and unlimited exposure. Because no contaminants remain at the site in the surface media at concentrations of concern, CERCLA Five-Year Reviews of this site are not required. Therefore, none of the CERCLA 121 statutory determinations need to be addressed.

1.5 Authorizing Signatures

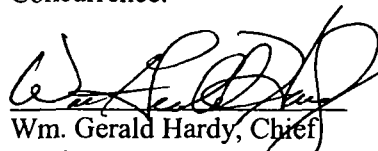


John A. Olshefski Date
Colonel, US Army
Garrison Commander



Franklin E. Hill, Director Date
Superfund Division
U.S. Environmental Protection Agency,
Region 4

Concurrence:



Wm. Gerald Hardy, Chief Date
Land Division
Alabama Department of
Environmental Management

2.0 Decision Summary

2.1 Site Name, Location, and Description

Inactive Abandoned Drum Disposal Site/Inactive Cyanide Lagoon (MSFC-002/087)
OU-18
Redstone Arsenal
Madison County, Alabama

CERCLA Identification Number: AL7 210 020 742

Lead Agency: Army

Redstone Arsenal is located in the southwestern portion of Madison County, which is in the northern portion of Alabama (Figure 1). Redstone Arsenal is bounded by the city of Huntsville on the north and east and the Tennessee River to the south. The city of Madison and the town of Triana are northwest and southwest, respectively, of Redstone Arsenal (Figure 1).

Redstone Arsenal is a U.S. Army facility that encompasses approximately 38,300 acres of land (Figure 2). Development within Redstone Arsenal has largely revolved around the historical need to produce (and later dispose of) conventional and chemical munitions and, more recently, to develop and test missiles and rockets. Chemical wastes have resulted from these processes since operations began in the early 1940s. Redstone Arsenal is composed of the U.S. Fish and Wildlife Service's (USFWS) Wheeler National Wildlife Refuge to the south; industrial areas in the southeast portion; facilities at the National Aeronautics and Space Administration's (NASA) George C. Marshall Space Flight Center (MSFC) for space flight research in the central portion; and family housing and commercial, recreational, and medical centers in the north portion. Missile/rocket testing and munitions storage, along with the associated range fans, test area safety fans, and explosive safety-quantity distance arcs, have been reserved for the southern portion of Redstone Arsenal.

MSFC-087 was a NASA-administered CERCLA site that was administratively combined with MSFC-002, an Army-administered CERCLA site at the request of EPA in 2004. Former site MSFC-087 is located within MSFC-002 and lies within the east-central portion of MSFC-002 within the MSFC facility boundary. The Army has now accepted responsibility for the completion of the investigation and closure of MSFC-087 as combined with MSFC-002. MSFC-087 is not listed as a CERCLA site on Redstone Arsenal's RCRA Part B permit or in the facility's CERCLA Installation Action Plan (Army, 2008a).

MSFC-002/087 lies on approximately 24 acres in OU-18 on the west-central portion of Redstone Arsenal, immediately west of Buildings 4754 and 4755. The western two-thirds of MSFC-002/087 are located on Redstone Arsenal property, while the eastern third of the site is located on property granted to NASA by the U.S. Department of Defense (see Figure 2) (Army, 1994; NASA, 2005). The site is not in active use. The land is primarily wooded and slopes toward Indian Creek and the unnamed ponds just west of the site. A large portion of the site is located within the 100-year floodplain of the Tennessee River, and the site is known to be periodically covered in flood waters (e.g., annual flooding is typical). Precipitation infiltrates the ground or runs off into the ponds or the shallow swale that drains the ponds. There is no direct path for site runoff to enter Indian Creek, although surface waters are mixed during flood events. However, runoff is likely limited due to the low topographic relief in the western portion of the site and the heavily forested nature of the land surface.

2.2 Site History and Enforcement Activities

This section presents a history of site activities and describes investigative, removal, and CERCLA or RCRA enforcement activities at MSFC-002/087.

2.2.1 History of Site Activities

MSFC-002/087 consists of an abandoned aboveground dump site and an inactive cyanide lagoon. Debris piles and mounds are scattered across the site in four primary portions of the site: northwest, north-central, east-central, and south-central. The debris piles and mounds consist primarily of construction/building demolition materials, including roofing materials, asphalt, concrete piping and slabs, clay bricks and piping, and miscellaneous construction debris (Figure 3). Limited other debris present consists of empty 55-gallon drums, drum carcasses, truck tires, and empty paint cans. The debris piles and mounds are overgrown with small woody shrubs, vines, trees, and grasses. Disposal was believed to occur for a short period of time in the 1960s. In about 1956, the western edge of the site was used for gravel borrow areas. These borrow areas have since filled up with water and formed ponds. Historical aerial photographs (1950s-1960s) show access roads across the site for the four primary disposal areas and the borrow areas. There is no evidence of additional ground disturbances since the 1970s from a review of the historical photographs. "NASA Spring," also known as "William's Spring", is located in the southern portion of MSFC-002/087, and no disposal activity was noted within 200 feet of the spring.

Also present within the MSFC-002/087 site boundary is the inactive cyanide lagoon. The cyanide lagoon was designed and built as part of the primary water pollution control facilities for

NASA in 1968. The lagoon was used from 1968 until approximately the mid-1970s. The lagoon was constructed to measure 28 feet by 35 feet, with 2:1 sloped sides and a 4-inch-thick concrete bottom. Historical aerial photographs have been used to positively identify the location of the lagoon. As of the winter of 2005, there was no physical evidence of the lagoon left at the site. A bow-shaped depression exists immediately south of the lagoon location and appears as a sump-like feature. The lagoon received wastes from a 520-gallon cyanide catch tank associated with the plating shop operations in Building 4760 that were periodically drummed and transported to the lagoon for disposal (wastes included numerous metals, cyanide, and trichloroethene [TCE]). A second waste stream was also believed to be disposed at the lagoon from a photographic laboratory process (ferricyanide waste). The use of the industrial waste treatment facility was phased out during the late 1970s and into the 1980s. NASA decided to close the wastewater treatment facility, including the cyanide lagoon, in 1987. The closure was accepted by ADEM in 1990. Wastes were removed from the lagoon as part of the closure. Surface soil and subsurface soil confirmation sampling was conducted to ensure that contaminated soil/waste was removed (CH2M Hill, 1999).

A more detailed description of the site history can be found in Section 1.6 in the remedial investigation (RI) report (Shaw Environmental, Inc. [Shaw], 2008a).

2.2.2 History of Investigative Activities

A number of assessments/investigations have been conducted at MSFC-002/087. The initial investigations conducted specifically at MSFC-002 from 1989 through 2003 included the following:

- MSFC-002 (referred to as Abandoned Drum Disposal Area) was evaluated in an interim RCRA facility assessment of MSFC in 1989 by EPA (A.T. Kearney, 1989). No samples were collected.
- A final RCRA facility assessment was conducted in 1989 by the Army (Geraghty & Miller, Inc., 1991). No samples were collected.
- A site screening RI (consistent with a site investigation [SI]) was conducted from 1995 to 1996 to determine the presence or absence of contamination in soil and groundwater (Rust Environment & Infrastructure, Inc. [Rust], 1998).
- An expanded SI was completed in 1999 to fill data gaps in soil, groundwater, surface water, and sediment to complete the SI (Shaw, 2008a).
- An RI was initiated in 2003 to determine the nature and extent of contamination in soil, groundwater, sediment, and surface water (Shaw, 2008a).

A number of initial investigations have also been conducted specifically at MSFC-087 from 1989 through 1997, as follows:

- MSFC-087 (referred to as a cyanide pit site) was evaluated in an interim RCRA facility assessment of MSFC in 1989 by EPA (A.T. Kearney, 1989). No samples were collected.
- MSFC-087 (referred to as a cyanide pit site) was evaluated in a preliminary assessment conducted in 1988-1989 (Harmon Engineering Associates, Inc., 1989). Initial sampling was conducted to confirm that the pit had been operational.
- By 1990, the cyanide lagoon was closed and waste/soil was removed (CH2M Hill, 1999).
- A Phase I RI was conducted in 1996 to determine the nature and extent of contamination in soil, sediment, and groundwater (CH2M Hill, 1997).
- A Phase II RI was conducted in 1997 to further investigate surface soil contamination (CH2M Hill, 1999).

As noted in Section 2.1, each site was on a separate investigative track in the CERCLA process until 2004. Below are the site activities and reporting that were conducted at the combined MSFC-002/087 site:

- RI activities were conducted in 2005 to determine the nature and extent of contamination in soil, groundwater, sediment, spring water, and surface water (Shaw, 2008a).
- A supplemental RI was conducted in 2006 to more completely define the nature and extent of soil and sediment contamination at the site where data gaps were noted (Shaw, 2008a).
- An NTCRA was conducted in 2007 for removal of surface and near-surface soil contaminated with elevated concentrations of pesticides and PAHs to address the environmental threats at the site (Shaw, 2008b).
- A statement of basis (SB)/proposed plan (PP) was developed to inform the public about the Preferred Alternative and to solicit public input to the selection process (Shaw, 2008c). The Preferred Alternative is NFA.

2.2.3 Site Removal Actions

As part of NASA's activities to close its industrial wastewater treatment facility under RCRA, soils and waste were removed from the former cyanide lagoon in 1987. This closure was accepted by ADEM in 1990. During the closure, waste/soil was removed from the lagoon and

confirmatory surface soil and subsurface soil samples were collected for analysis (CH2M Hill, 1999). Additional sampling conducted more recently during the RI at the lagoon confirmed that the contamination has been removed.

From June to September 2007 the Army conducted an NTCRA at the MSFC-002 portion of the site. The NTCRA focused on the removal of surface and near-surface soils contaminated with PAHs and pesticides to prevent migration of contaminated soils to adjacent sensitive aquatic habitats and wetlands (Shaw, 2008b). In 2006, the Army, EPA, and ADEM agreed that conducting an NTCRA at MSFC-002/087 would achieve the health protective objectives because the contaminants were restricted to a small area where the COCs are collocated in surface or near surface soil. In addition, an NTCRA was conducted to address site conditions that were identified in 40 Code of Regulations 300.415 (b) (2). The NTCRA addressed elevated concentrations of the pesticide dichlorodiphenyltrichloroethane (DDT) and its metabolites and PAHs identified in surface and near-surface soil in the debris piles and mounds as posing unacceptable risks to ecological and human health receptors in the final RI report (Shaw, 2008a). No additional removal was needed at the cyanide lagoon since that area of the site was further sampled and evaluated in the RI and determined to pose no unacceptable risks. During the NTCRA, the Army removed a total of 73 cubic yards of soil from five debris pile and mound locations. The locations for the soil excavations were selected based on concentrations of contaminants present and their locations within the floodplain area. Two locations were partially excavated to a 4-foot depth, and the remaining locations were excavated to a depth of 1 foot below ground surface (bgs). Once the soil was removed from the excavations, confirmation soil sampling was performed to ensure that sufficient contaminated soil was removed. The excavated material from the debris piles was classified as nonhazardous CERCLA waste based on its site history and analytical data. The soil was disposed at the Allied Subtitle D Landfill in Hillsboro, Alabama as approved by ADEM. Once the removal action was completed, the Army used clean soil to backfill the excavated areas. The results of the NTCRA are presented in the closure report for this action (Shaw, 2008b).

2.2.4 History of CERCLA or RCRA Enforcement Activities

No CERCLA or RCRA enforcement activities have been conducted to date at MSFC-002/087.

2.3 Community Participation

Throughout Redstone Arsenal's history, community concern and involvement have been low. The Army has kept the community and other interested parties apprised of site activities through the following:

- Informational materials and presentations
- Press releases
- Administrative Record file and information repositories
- Public meetings and comment periods.

Informational materials, such as fact sheets, are periodically sent to community members and are made available to the public at public meetings. A mailing list of community members and individuals that have requested information is maintained by the Army. Fact Sheet 24, Non-Time-Critical Removal Action at MSFC-002/087 was recently prepared and is available to the public (Shaw, 2008d). Presentations and tours for community groups are aimed specifically for members of the public and are also announced through mailings or by the media. A community relations plan (Shaw, 2006) has been published to keep the community informed of cleanup progress at Redstone Arsenal and to provide opportunities for the public to interact with the Army on remedial activities.

A complete set of documents (hard copy and CD) used to make decisions about the cleanup efforts at MSFC-002/087 is available in the Administrative Record file managed on post by the Army's Environmental Office. Electronic copies on CD are also located at local libraries. See Exhibit 1 for a listing of locations and phone numbers for more information.

Exhibit 1: Administrative Record File and Information Repository Locations

Administrative Record File:

U.S. Army Garrison, Redstone Arsenal

Contact: Ms. Salee Sloan (256) 842-0314
 Location: Environmental Management Division, 7741 Sandpiper Road
 Business Hours: Monday – Friday, 7:00 a.m. – 4:30 p.m. Central time zone

Information Repositories:

Triana Public Library (Triana Youth Center)

Contact: Ms. Wendy Qualls (256) 772-3677
 Location: 280 Zierdt Road, Triana, Alabama
 Business Hours: Monday – Friday, 11:30 a.m. – 6 p.m.; and First and Third Saturdays, 12:00 p.m. – 5 p.m. Central time zone

Huntsville-Madison County Public Library

Contact: Ms. Anne Fuller (256) 532-5969
 Location: Heritage Room, 915 Monroe Street, Huntsville, Alabama
 Business Hours: Monday – Thursday, 9 a.m. – 9 p.m.; Friday – Saturday, 9 a.m. – 5 p.m.; and Sunday, 1 p.m. – 5 p.m. Central time zone

Documents covering MSFC-002/087 can also be obtained on line by going to the archived documents under the Restoration Branch of the Army's public website www.environmental.redstone.army.mil or by emailing the request to EnvironmentalOffice@redstone.army.mil. This ROD will become part of the Administrative Record file [NCP 300.825(a)(2)].

The final RI report was released to the Administrative Record file and made available to the public in April 2008 (Shaw, 2008a). The SB/PP was released in March 2008 (Shaw, 2008c) for public review. A public comment period was held from April 2 to May 1, 2008. A notice of availability of the MSFC-002/087 RI report, the SB/PP, and other related documents in the Administrative Record file was published in *The Huntsville Times* on April 2 and April 6, 2008; in the *Speakin' Out News* on April 2, 2008; and in the *Redstone Rocket* on April 9, 2008. The SB/PP stated that a public meeting would be held if there was sufficient interest from the public. A meeting was not requested. Comments were received during the public comment period and the responses to the comments are presented in the Responsiveness Summary provided in Chapter 3.0.

2.4 Scope and Role of Operable Unit and Response Action

This section includes the scope and role of the response action for MSFC-002/087 within the cleanup strategy for Redstone Arsenal, the scope of the problems addressed by the response action for MSFC-002/087, and a description of the consistency between the final remedy selected for MSFC-002/087 and the removal action taken at the site.

2.4.1 Overall Remedial Strategy for Redstone Arsenal and MSFC-002/087

The environmental concerns at Redstone Arsenal are extremely complex. As a result, work at over 200 sites in the Installation Restoration Program (IRP) at Redstone Arsenal has been underway and the sites have been organized into 20 OUs. These OUs have recently been defined based on similarities in historical processes or functions which have resulted in site releases of a similar nature (Shaw, 2007a).

This ROD is the final action for surface media at OU-18, MSFC-002/087. Final RODs for surface media have been approved at OU-5, RSA-049; OU-6, RSA-057; OU-10, RSA-011; OU-2, RSA-047; and OU-10, RSA-099. An interim record of decision (IROD) has been approved for groundwater land use control in OU-19. Numerous investigations at the remaining sites are underway.

The Selected Remedy in this ROD is for surface media at OU-18, MSFC-002/087, which include the surface soil, subsurface soil, sediment, surface water, spring water, and soil vapor located within the site boundary. Surface media do not include groundwater under the site, which is being investigated as part of the more comprehensive RSA-149 groundwater site. The groundwater under MSFC-002/087, like many of the CERCLA sites at Redstone Arsenal, may encompass contributions of contaminants from more than one surface media site in the area. The final remedy for the RSA-149 groundwater site will be selected after completion of an RI/feasibility study, and any actions that may be needed to address groundwater located under MSFC-002/087 would be included as part of this RSA-149 remedy.

As presented in Section 2.2.3, contaminants have been removed at the site. There is now no need for additional response actions for surface media at MSFC-002/087, because the site currently poses no unacceptable risks to human health or the environment.

2.4.2 Scope of Problems Addressed by MSFC-002/087 Response Action

The action or scope covered by the final response action at MSFC-002/087 consists of the surface media, which include the surface soil, subsurface soil, soil vapor, sediment, surface water, and spring water. No problems currently exist in the surface media that require additional remedial action under present and planned future industrial land uses or under hypothetical future residential uses. The remedy of NFA for MSFC-002/087 surface media is the Selected Remedy.

2.4.3 Consistency Between the Final Remedy Selected and the Removal Action

The soil contamination at the debris piles and mounds identified in the RI has been addressed by the NTCRA (Shaw, 2008b) recently conducted by the Army. No additional soil removal was needed at the cyanide lagoon in the NTCRA because this area does not pose unacceptable risks to human health or ecological receptors. The objective of the NTCRA at the debris piles and mounds was to prevent migration of contaminated soils to adjacent sensitive aquatic habitats and wetlands during periodic flood conditions. Additionally, several COCs were identified that posed unacceptable risks to ecological and human health receptors. An NTCRA was conducted at MSFC-002/087 because the actual or threatened release of contaminants may present an imminent and substantial endangerment to public health or welfare, or the environment. The Army used its removal action authority in conjunction with oversight by EPA and ADEM. The NTCRA has resulted in site conditions where contaminants do not pose a migration threat to adjacent aquatic and wetland habitats; migration of contaminants to groundwater is not expected to occur at this site as well. Risk assessments were performed using contaminant concentrations remaining in site media after the NTCRA. These assessments demonstrated that the site does not

pose unacceptable risk to human health or the environment under current or future industrial or future unrestricted use exposure scenarios. The NTCRA that has been conducted at the site achieved its remedial action objectives of removing contaminated soils which posed unacceptable risks to human health and the environment. As a result, the final remedy of NFA is selected in this ROD. Groundwater under MSFC-002/087 will be further evaluated as part of the RI effort for groundwater site RSA-149.

2.5 Site Characteristics

MSFC-002/087 is a wedge-shaped site located on approximately 24 acres in a little-used portion of Redstone Arsenal and MSFC. Buildings 4754 and 4755 are just east of the site. The site is located just north of Martin Road and just west of Tiros Street (Figure 2). The land is mostly tree covered and is not currently in active use. The site is not fenced, but there are signs around the site perimeter warning that site access is limited to authorized personnel. Hunting is not currently permitted on the site. Although no CERCLA or RCRA sites are immediately adjacent to MSFC-002/087, the area just east of the site contains active facilities and administrative buildings for space technology development at MSFC.

Several construction-related debris piles and mounds are scattered throughout the site and there is no remaining evidence of the former cyanide lagoon in the east-central portion of the site. The debris piles and mounds are overgrown with small shrubs, vines, trees, and grass (Figure 3). The land slopes from the northeast to the unnamed ponds and Indian Creek to the southwest. The ponds originated from excavation of gravel around 1956. A large portion of the site, including the debris piles and mounds, is within the 100-year floodplain of the Tennessee River. A large spring ("NASA Spring") is present in the southern portion of the site but was not part of the areas used for debris disposal. Shallow creeks and ditches drain NASA Spring.

Depth to groundwater at MSFC-002/087 ranges from a maximum depth of approximately 25 feet bgs in the northeast (topographic high portion of the site) to a maximum depth of approximately 3-5 feet bgs in the southwestern portion of the site near the ponds. The groundwater flow is predominantly to the south/southwest. Figure 4 presents the conceptual site model (CSM) for MSFC-002/087. Because of the nature of the debris disposal at the site, contaminants have historically leaked from the debris and become mixed with the shallow underlying and surrounding soil. These contaminants posed a potential threat to human health and the environment, including sensitive surface water and floodplain habitats.

The significant findings of the RI with respect to known or suspected sources of contamination, types of contamination, and affected media are summarized in the following sections.

2.5.1 Conceptual Site Model

A CSM is a three-dimensional “picture” of site conditions that illustrates contaminant sources, release mechanisms, exposure pathways, migration routes, and potential human and ecological receptors. The CSM presented on Figure 4 shows the geologic and hydrogeologic setting of MSFC-002/087. The CSM shows these areas relative to major surface and subsurface features at or near the site.

The main components of the CSM presented on Figure 4 include the following:

- Former site MSFC-087 originated from the discharge of cyanide wastes to a lagoon.
- MSFC-002 originated from the disposal of construction-related wastes in piles and mounds at the site in the 1960s. The debris includes roofing materials, asphalt, concrete piping and slabs, clay bricks and piping, empty 55-gallon drums, drum carcasses, truck tires, empty paint cans, and miscellaneous materials.
- The contaminants detected in soil from migration of the debris to soil include PAHs and pesticides.
- PAHs have been detected in soil as a result of the disposal of construction-related wastes (e.g., concrete slabs) in the debris piles and mounds at the site. PAHs are relatively immobile in soil and are not leaching to groundwater.
- Pesticides have also been detected in soil at the debris piles and mounds presumably from the disposal of general waste containing residual DDT and other pesticides. Pesticides were also detected ubiquitously throughout the site, presumably from the past legal application to control the insect population (e.g., mosquitoes) at the site. Pesticides are essentially immobile in the soil and do not leach to groundwater.
- No principal threat waste or low-level threat waste (EPA, 1991a) is present at MSFC-002/087.
- Waste/soil was removed at the cyanide lagoon before it was closed in 1990 (CH2M Hill, 1999). Cyanide was detected at low concentrations in and around the former cyanide lagoon in the RI.
- An NTCRA was conducted at the site in 2007 to remove elevated concentrations of PAH- and pesticide-contaminated soil/debris from several debris piles and mounds. Figure 5 shows the removal action excavation areas. Subsequent to the removal action, exposure to soils and groundwater has posed no unacceptable threat to any receptor from site-related chemicals.

- Surface runoff presents a minor migration pathway for surface soil PAHs and pesticides. PAHs and pesticides have not been detected in surface water (ponds) and, in general, only low concentrations have been detected in sediments.
- Concentrations of potential volatile organic compounds (VOC) in soil vapor were modeled from concentrations of VOCs in site groundwater.
- Depth to groundwater at MSFC-002/087 ranges from about 25 feet bgs in the northeast (topographic high portion of the site) to approximately 3 to 5 feet bgs in the southwestern portion of the site near the ponds. The groundwater flow is predominantly to the south-southwest.

Current and future potential human receptors evaluated for MSFC-002/087 include groundskeepers, construction workers, sportsmen, and trespassers, any of which might, under specific circumstances, be exposed to site-related contamination. Additionally, a hypothetical residential receptor has been evaluated for a future scenario. The hypothetical residential evaluation provides a basis for cost comparisons between cleanup options that would allow for unrestricted site use versus other cleanup options where life cycle costs for maintaining land-use controls would be incurred.

- The site is not maintained on a regular basis; however, the groundskeeper serves as a conservative surrogate for all site workers who might be exposed to surface soil. The groundskeeper, who typically cuts the grass, could be exposed to soil through incidental dermal contact, inhalation of chromium in soil particulates, or incidental ingestion. The soil at the site is covered by vegetation such that there would be minimal direct exposure to soils.
- A construction worker was included as a plausible receptor for evaluating subsurface soil and total soil.
- A trespasser was included as a plausible receptor to evaluate recurring exposure of a youthful, unauthorized entrant to the surface soil and surface water at the site.
- The site is currently restricted from hunting, although hunting could be allowed at MSFC-002/087 in the future. In addition, the site is adjacent to land that is used for hunting and thus, could support deer that could be consumed by current hunters. For these reasons, a future sportsman was considered to be as a plausible receptor for this site.
- Potential groundwater exposure pathways are incomplete under current conditions because groundwater is not utilized as a potable water supply on Redstone Arsenal (Army, 2006a; Shaw, 2007b,c). Exposure to groundwater was evaluated in the risk assessment to meet requirements for assessing risks from multiple media cumulatively, as specified under the NCP. This assessment is needed since the current remedy in place for groundwater is only an interim remedy (EPA, 1991b).

Most of MSFC-002/087 is currently wooded. There are aquatic habitat areas adjacent to MSFC-002/087. As stated in Redstone Arsenal's *Endangered Species Management Plan* (ESMP) (Army, 2005), some threatened or endangered species may visit this site, while one special status species, the Tuscumbia darter, is known to be present in NASA Spring. Ecological receptors may be exposed to contaminants present in surface soil, surface water, sediment, and spring water at this site; to contaminants that have been accumulated in site vegetation or soil invertebrates; or to contaminants distributed further within the food web at this site. No areas of archeological or historical importance are present at MSFC-002/087. The site risks are discussed in Section 2.7.

2.5.2 Nature and Extent of Contamination Prior to Removal Action

Surface soil, subsurface soil, groundwater, surface water, sediment, and spring water sampling in and around the debris piles and cyanide lagoon at MSFC-002/087 began in the early 1990s and concluded by 2007. Figure 6 shows the sample locations from the SI and RIs conducted at the site. The SI report (Rust, 1998) and RI reports (CH2M Hill, 1997, 1999; Shaw, 2008a) contain the detailed sample information, analytical data, the screening criteria for data evaluation, and maps for all the investigations conducted at the site.

EPA has published studies that estimate health and environmental risks associated with many of the organic and inorganic compounds found in the environment at Redstone Arsenal. Analytical data from MSFC-002/087 were compared to EPA Region 9 preliminary remediation goals (PRG) (EPA, 2004a) to initially identify the presence and scope of contamination in site media. Surface soil data were compared to the residential PRGs and subsurface soil data were compared to the industrial PRGs. PRGs combine current human health toxicity values with standard exposure factors to estimate contaminant concentrations in environmental media (soil, air, and water) that are considered by EPA to be health protective of human exposures (including sensitive groups) over a lifetime. Exceeding a PRG suggests that further evaluation of the potential risks that may be posed by site contaminants is appropriate.

Below is a summary of the characterization by medium for the site conditions encountered at MSFC-002/087 before the NTCRA.

2.5.2.1 Nature and Extent of Soil Contamination

Surface Soil. The debris piles are located in four major areas of the site: northwest, north-central, east-central, and south-central. Surface soil samples have been collected in and around

the piles and mounds to determine the nature and extent of contamination. Table 1 presents a summary of select PAH and pesticide data in surface soil at the site. Figure 6 presents the existing SI/RI sample locations. Pesticides, particularly DDT and its metabolites and PAHs, were identified as site-related constituents present in surface soil. Pesticides appear to have been transported to the site as part of the general debris disposed of at this site. DDT, dichlorodiphenyldichloroethene (DDE), and heptachlor epoxide were detected at maximum concentrations of 23, 2.4, and 0.084 milligrams per kilogram (mg/kg) respectively, exceeding their associated EPA Region 9 PRGs. Other pesticides were detected at low concentrations outside of areas identified as debris piles, and their somewhat ubiquitous nature suggests that the presence of these compounds may have been linked to historical spraying to control insect populations (e.g., aerial application across Redstone Arsenal and MSFC to control mosquitoes). PAHs were found almost exclusively in only the debris piles and mounds. PAHs, including benzo(a) pyrene, dibenz(a,h)anthracene and benzo(a)anthracene, were detected at concentrations above their respective PRGs.

Surface soil analytical samples collected in and around the cyanide lagoon in the RI, including the sump-like feature south of the lagoon, revealed only minimal residual contamination. Wastes were previously removed from the lagoon by 1990. Cyanide was detected at relatively low concentrations (less than 1 mg/kg) below its residential PRG. Metals and TCE associated with the plating shop operations were not detected frequently or in relatively high concentrations. No residual source of cyanide-containing soil that could be a continuing source of contamination to groundwater is present at or around the lagoon.

Subsurface Soil. Subsurface soil analytical results indicate that the debris piles contain pesticides (such as DDT), PAHs (such as benzo[a] pyrene and benzo[b]fluoranthene), and VOCs. DDT concentration from one location at a concentration of 7.4 mg/kg exceeded its EPA Region 9 industrial PRG. Four detections of benzo(a) pyrene (0.29 J to 7.4 mg/kg) exceeded the industrial PRG. Table 2 presents a summary of select PAH and pesticide data in subsurface soil at the site. Figure 6 presents the existing SI/RI sample locations.

Subsurface soil analytical samples collected in and around the cyanide lagoon during the RI, including the sump-like feature south of the lagoon, revealed only minimal residual contamination. Cyanide was detected at concentrations below its industrial PRG and dilution attenuation factor 4 (DAF₄) soil screening level (SSL). Metals and VOCs (TCE) associated with the plating shop operations were not detected frequently or in relatively high concentrations. No residual source of cyanide-containing soil that could be a continuing source of contamination to groundwater is present at or around the lagoon following the removal of waste by 1990.

2.5.2.2 Nature and Extent of Groundwater Contamination

To evaluate the potential leaching of contaminants in the debris piles and mounds and the former cyanide lagoon to the underlying groundwater, overburden groundwater samples were collected from six monitoring wells (Figure 6). No pesticides or PAHs were detected in the samples from the three monitoring wells constructed within the boundaries of the debris piles. TCE was detected in groundwater in the 2003 and 2004 sampling events at concentrations ranging from 0.31 µg/L to 13 micrograms per liter (µg/L), which exceeded the EPA Region 9 tap water PRG. One sample exceeded the maximum contaminant level in groundwater for TCE (5 µg/L). When the groundwater was re-sampled in 2005, however, no TCE was detected. The highest concentration (13 µg/L) detected previously was in an upgradient well, which suggests the source of TCE was off site. Additionally, no on-site source has been determined for TCE.

2.5.2.3 Nature and Extent of Surface Water and Sediment Contamination

To evaluate the potential migration of contaminants from the debris piles and the former cyanide lagoon to surface water features at the site, surface water and sediment samples were collected from Indian Creek, the unnamed ponds immediately down slope of the debris piles, and the drainage features associated with NASA Spring. Overall contaminant levels in surface water and sediment appear similar to contaminant levels found in soil samples between the debris piles (e.g., low levels of pesticides consistent with large-scale spraying for insects but no significant PAHs). It does not appear that surface water runoff or flood waters are dispersing PAHs from the debris piles. Cyanide was not detected in the 1999 data set for sediment and surface water samples collected from the ponds. It was detected in the surface water and sediment samples from 2005 but then was only detected in one of four sediment samples collected in 2006. The additional site sampling confirmed that the cyanide was not deposited in the ponds from surface runoff at the site.

2.5.3 Nature and Extent of Contamination After Removal Action

From June to September 2007, the Army conducted an NTCRA at MSFC-002/087 (Figure 5). The action focused on the removal of surface and near-surface soils contaminated with PAHs and pesticides. The objective of the NTCRA was to prevent migration of contaminated soils to adjacent sensitive aquatic habitats and wetlands. The removal action addressed the COCs DDT, DDE, dichlorodiphenyldichloroethane (DDD), and PAHs, which were found to pose unacceptable risks to ecological and human health receptors in the RI report (Shaw, 2008a).

Approximately 73 cubic yards of soil were removed from five debris pile locations at the site during the removal action. Two locations were partially excavated to a 4-foot depth and the

remaining locations were excavated to a depth of 1 foot bgs. Once the soil was removed from the excavation, confirmation soil sampling was performed to ensure that sufficient contaminated soil was removed. The Army then used clean soil to backfill the excavated areas. The results of the NTCRA were presented in the closure report for this action (Shaw, 2008b).

Concentrations of DDT in surface soil were reduced from a maximum of 23 mg/kg and an average of 0.931 mg/kg to a maximum of 1 mg/kg and an average of 0.0896 mg/kg.

Benzo(a)pyrene in surface soil was reduced from a maximum of 21 mg/kg and an average of 0.643 mg/kg to a maximum of 0.92 mg/kg and an average of 0.222 mg/kg. Similar reductions in concentration were achieved for the metabolites of DDT and for other PAHs (Shaw, 2008b).

Concentrations of DDT and its metabolites and PAHs in subsurface soils were also significantly reduced by this removal action.

2.5.4 Fate and Transport

Potential migration routes for contaminants were identified and evaluated at MSFC-002/087 in Chapter 6 of the RI report (Shaw, 2008a). The conclusions of this evaluation for the primary contaminants at the site (PAHs, pesticides, and cyanide) are as follows:

- Formation of leachate and vertical transport in soil to groundwater. Pesticides and PAHs were detected in surface and subsurface soils at concentrations exceeding the DAF₄ SSL. However, these compounds were not detected in groundwater samples above maximum contaminant levels and travel times were calculated to exceed 790 years. Therefore, groundwater is not expected to be impacted in the future from PAHs and pesticides.
- Transport of PAH or pesticide contaminants from site surface soils to adjacent waterways via surface runoff was evaluated for this site. Significant erosion and transport of PAHs from the debris piles via surface runoff does not appear to be occurring at MSFC-002/087 since few PAHs have been detected in the samples of surface water and sediment collected at the site.
- Cyanide concentrations detected in site soil samples were less than the SSL and cyanide has not been detected in groundwater. The travel time indicates that cyanide travel times are relatively high (on the order of 1,626 years), and cyanide in soil was not considered a future threat to the overburden groundwater underlying the site.
- The cyanide detections in the 2005 surface water and sediment samples were determined to be anomalous, considering that the previous or subsequent data did not report cyanide at the frequency or with the magnitude of detections reported in the 2005 data. The possibility exists that the cyanide was from decaying plant matter (i.e., naturally occurring).

2.6 Current and Potential Future Land and Resources Use

The western two-thirds of MSFC-002/087 are located on Redstone Arsenal property, while the eastern third of the site is located on property granted to NASA by the U.S. Department of Defense (see Figure 2) (Army, 1994; NASA, 2005). This section presents current and future land use and groundwater use for both portions of this site.

2.6.1 Current and Future Land Use

Current Land Use. The current land use for the Army-controlled portion of the site is classified as industrial for a weapons test area (Army, 2006b). The southeastern portion of the site lies within the MSFC-controlled area for space technology developments. The site is currently inactive. The land is heavily wooded and slopes from upland areas in the eastern-northeastern portion of the site to the ponds adjacent to Indian Creek on the west/southwest (Figure 2). The majority of the site is located within the 100-year floodplain, and one designated environmentally sensitive area, NASA Spring, is located within the site boundary. The presence of these features would likely influence the use of this site because a change to active use would require coordination under the National Environmental Policy Act (NEPA). Although no CERCLA or RCRA sites are immediately adjacent to MSFC-002/087, the area just east of the site contains active facilities and administrative buildings for space technology development at MSFC. Current land use in the areas surrounding MSFC-002/087 to the north, west, and south is classified as weapons test area but is actually open space consisting largely of wetland and floodplain areas.

No recreational activities (e.g., hunting, fishing, camping, hiking) are currently permitted at MSFC-002/087. The site is not fenced, but there are signs around the site perimeter warning that site access is limited to authorized personnel. Areas outside of MSFC-002/087 are permitted for hunting. Recreational hunters are authorized entry onto Redstone Arsenal through staffed security gates at the facility boundaries. Individuals accessing Redstone Arsenal for any recreational purposes are directed to the outdoor recreation office for maps. These maps identify all approved hunting areas as well as other recreational areas. Prohibited areas such as CERCLA sites (i.e., MSFC-002/087) are noted on the maps. Game wardens and other security personnel routinely enforce the recreational use regulations on Redstone Arsenal. Where practical, the Army restricts entry into environmental sites by fencing them and/or by placing warning signs at key entry points per the Site Access Control (SAC) program (Army, 2006a). The ponds on the western perimeter of the site are not sufficient to support sport fishing or swimming, but they do

provide surface water in which a hunter or trespasser may wade during recreational activities. No routine maintenance activities are currently performed in these ponds.

Future Land Use. Future land use in the area of MSFC-002/087 is planned as research, development, testing, and evaluation (Army, 2006b). Land use in the southeast portion of MSFC-002/087 and areas to the east include active areas of MSFC for space research. There is a possibility that the entire site or a portion of the site could be developed for active use by NASA at some point in the future. The wetland areas to the north, west, and south of the site are anticipated to remain as open space though portions of these areas also have a future land use classification of research, development, testing, and evaluation. Although future land use of this site for hunting or recreation activities is possible, no residential or day care facilities are planned or anticipated for MSFC-002/087 in the future.

2.6.2 Groundwater Use

Current Groundwater Use. MSFC-002/087 groundwater is not currently used for human consumption or for any nonpotable uses. The Tennessee River is the source of potable water for both consumption and the majority of nonpotable uses on Redstone Arsenal. Local residents and Arsenal workers receive their potable water from the Huntsville Utilities where water is derived from the Tennessee River. The Tennessee River is over three miles to the south of MSFC-002/087. The Army SAC program (Army, 2006a) requires that all well requests on Redstone Arsenal be reviewed and installation of wells for drinking water, industrial purposes, or agricultural processes are prohibited. MSFC has a similar program in place. Redstone's Installation-Wide Groundwater IROD, signed in September 2007, also prevents the current use of groundwater for potable purposes and ensures that any nonpotable uses of groundwater are reviewed and evaluated by the Army prior to being permitted (Shaw, 2007b,c). NASA also has an approved groundwater IROD under MSFC which contains similar provisions (CH2M Hill, 2007).

Future Groundwater Use. Under the provisions of the Army's and NASA's groundwater IRODs, groundwater resources at MSFC-002/087 or elsewhere on Redstone Arsenal may not be developed for potable purposes and groundwater withdrawals for nonpotable uses must be managed as discussed above. The IRODs apply to any groundwater site for which the final remedy has not been selected. The IRODs are legal documents that will prevent use of the installation's groundwater as a potable water source and will manage nonpotable groundwater withdrawals for other purposes until remedies are selected in the final RODs for the various groundwater sites within Redstone Arsenal.

2.7 Site Risks

A baseline human health risk assessment (BHHRA) and screening-level ecological risk assessment (SLERA) were performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with MSFC-002/087 after the NTCRA was performed (Shaw, 2008a). These risk assessments support the need for NFA at this site. A summary of the aspects of the BHHRA which support the determination that no additional remedial action is necessary to ensure the protection of human health and the environment is presented below followed by a summary of the SLERA. The complete BHHRA and SLERA can be found in Appendices F and G, respectively, of the RI report for MSFC-002/087 (Shaw, 2008a).

As discussed in Section 2.5.3, an NTCRA for selected pesticides DDD, DDE, DDT, and PAHs was performed for MSFC-002/087. The Army used their removal action authority in conjunction with oversight by EPA and ADEM. The objective of the NTCRA was to prevent migration of contaminated soils to adjacent sensitive aquatic habitats and wetlands. The removal action also addressed elevated concentrations of DDD, DDE, DDT, and PAHs in surface and subsurface soils which were found to pose unacceptable risks to ecological and human health receptors in the RI report (Shaw, 2008a).

2.7.1 Baseline Human Health Risk Assessment

The BHHRA performed following the NTCRA did not identify unacceptable risks for any receptor from exposure to surface media at MSFC-002/087. To reach this conclusion, the BHHRA calculated the risks from residual contamination remaining after the NTCRA removed soils containing high concentrations of PAHs and DDT, DDE, and DDD. The BHHRA followed a four-step process to estimate the baseline risk for human health: 1) hazard identification, which identified those hazardous substances which, given the specifics of the site, were of significant concern; 2) exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure; 3) toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances, and 4) risk characterization and uncertainty analysis, which integrated the three previous steps to estimate the potential and actual risks posed by hazardous substances at the site, including carcinogenic and noncarcinogenic risks and a discussion of the uncertainty in the risk estimates.

A summary of these steps of the human health risk assessment is presented below.

2.7.1.1 Identification of Chemicals of Potential Concern

A total of 15 of the 84 chemicals detected at the site were selected for evaluation in the BHHRA as chemicals of potential concern (COPC). The COPCs were selected to represent potential site-related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment. COPCs for surface soil, subsurface soil, total soil, and surface water can be found in Appendix F, Tables F-2 through F-4 and F-6, respectively, of the BHHRA presented in the RI report (Shaw, 2008a). A hypothetical medium called total soil was created by combining soil data from samples with starting depths of 10 feet bgs or less into one data set to evaluate the potential for subsurface soil to be brought to the surface during construction or excavation so that direct contact is plausible. Estimates of the exposure point concentrations used for all COPCs can be found in Appendix F, Table F-10 of the RI report (Shaw, 2008a). No COPCs were identified in spring water and groundwater. Although COPCs were identified in sediment, exposure to sediment, which is covered by water during most of the year, is not a significant route of exposure because the water would rinse the sediment away, reducing exposure to toxicologically insignificant levels. Therefore, sediment was not evaluated further. As presented in Attachment 2 of Appendix F of the BHHRA, the maximum detected concentrations of VOCs in groundwater were used to evaluate whether soil vapors originating from groundwater contamination could potentially pose unacceptable risks to a indoor worker or a resident if buildings were constructed on MSFC-002/087 in the future (Shaw, 2008a).

2.7.1.2 Exposure Assessment

Potential human health effects associated with exposure to COPCs were estimated quantitatively through the development of several hypothetical receptor scenarios and exposure pathways. These pathways were developed to reflect the potential for receptor exposure to hazardous substances based on the present site uses, potential future site uses, and location of MSFC-002/087. The current land use of the majority of MSFC-002/087 is classified as weapons test area. Its future industrial land use has been identified as Research, Development, Testing, and Evaluation (Army, 2006b). However, the southeast portion of MSFC-002/087 is part of MSFC, and areas to the east are actively used by MSFC for space research. Therefore, it is possible that the entire site could be developed for active use at some point in the future. There is no current administrative control prohibiting site development for residential purposes in the future. Therefore, risks to a hypothetical residential receptor were evaluated. This evaluation provides a basis for cost comparisons between cleanup options that would allow for unrestricted site use versus other cleanup options where life cycle costs for maintaining land-use controls would be incurred.

The following is a brief summary of the exposure pathways evaluated in the BHHRA. A more thorough description of exposure pathways evaluated can be found in Appendix F, Section F4.0 of the RI report (Shaw, 2008a).

Five human receptors were quantitatively evaluated in the exposure assessment. The groundskeeper and construction worker are considered industrial receptors; these receptors were evaluated under current and future land-use assumptions. The sportsman and trespasser are considered recreational receptors. The sportsman is considered to be a future receptor only because hunting is not currently allowed at the site. A hypothetical residential receptor was evaluated under a potential future site use which assumes that houses are built on MSFC-002/087.

Receptors could potentially come in contact with contaminants in site media by dermally contacting (touching), ingesting (eating), or inhaling (breathing in) site media. For exposure to soils, all three exposure routes were evaluated for the construction worker. The groundskeeper, sportsman, and trespasser receptors were evaluated for exposure to soils through ingestion and dermal contact only. No quantitative evaluation of the inhalation pathway was required for the groundskeeper, sportsman, or trespasser because chromium was not identified as a COPC in soil, as described in the RI report (Shaw, 2008a). The sportsman is assumed to consume venison from deer that have browsed on potentially contaminated soil as well. The ponds are not sufficient to support sport fishing, but they do provide surface water in which sportsmen or trespassers may wade. Consequently, the sportsman and trespasser were assumed to come in contact with surface water through dermal contact only. Hypothetical future residential adults and children were assumed to only come in contact with soils through ingestion and dermal contact, because in a residential setting soils would be covered by lawns, gardens, or pavement, reducing dust emissions from wind erosion to insignificant levels. No COPCs were identified in spring water and groundwater; therefore, potential exposure to these media was not evaluated.

No commercial buildings are located on the site currently. Therefore, a hypothetical future residential receptor was evaluated for exposure to soil vapors which may intrude into a hypothetical future residential building. The evaluation of the hypothetical residential receptor would also be protective of an indoor commercial worker should an industrial building be constructed on the site in the future.

TCE in groundwater was identified as a COPC for the vapor intrusion evaluation. To determine the exposure point concentration used to evaluate the vapor intrusion migration exposure pathway, indoor air concentrations were calculated based on the highest groundwater

concentrations found in groundwater samples collected from monitoring wells located on site. The Johnson and Ettinger vapor intrusion model was used to calculate indoor air concentrations based on groundwater sample results for TCE (EPA, 2004b; Johnson and Ettinger, 1991). Indoor air concentrations of TCE were calculated for a hypothetical future residential on-site house because there are no existing buildings on MSFC-002/087. However, indoor air concentrations calculated for the residential receptor would also be protective of a future indoor commercial worker should an industrial building be constructed on the site in the future. Attachment 2 to Appendix F of the RI report (Shaw, 2008a) presents the exposure assessment performed for the vapor intrusion evaluation.

2.7.1.3 Toxicity Assessment

The possible harmful effects to humans from the COPCs were evaluated. These chemicals were separated into two groups: carcinogens (COPCs that may cause cancer) and noncarcinogens (COPCs that may cause adverse health effects other than cancer). Chemicals that are considered to be carcinogens may cause noncancer adverse health effects as well. Both cancer and noncancer adverse health effects were evaluated for carcinogens, where applicable. Toxicity values used for quantitative evaluation of risks via the oral, dermal, and inhalation pathways are discussed in Appendix F, Section F5.0, and presented in Tables F-11, F-13, and F-14 of the RI report (Shaw, 2008a).

Cancer potency factors have been developed by EPA from epidemiological or animal studies to reflect a conservative “upper bound” of the risk posed by potentially carcinogenic compounds. Reference doses (RfD) for noncarcinogen compounds have been developed by EPA and they represent a level to which an individual may be exposed that is not expected to result in any deleterious effect. RfDs are derived from epidemiological or animal studies and incorporate uncertainty factors to help ensure that adverse health effects will not occur.

There is ongoing uncertainty in the regulatory community over the most scientifically valid inhalation slope factor to use for estimating risks from inhalation TCE vapors. Inhalation slope factors for TCE used in the vapor intrusion evaluation were based on two different sources. These sources included EPA’s National Center for Environmental Assessment evaluation of TCE (EPA, 2001) and California Environmental Protection Agency’s guidelines for describing cancer potency factors (California Environmental Protection Agency, 2002). Attachment 2 of Appendix F of the RI report (Shaw, 2008a) presents the toxicity assessment performed for the vapor intrusion evaluation.

2.7.1.4 Risk Characterization

The results from the exposure and toxicity assessment were combined to calculate the overall risks from exposure to site COPCs. Excess lifetime cancer risks were determined for each exposure pathway by multiplying a daily intake level with the chemical specific cancer potency factor.

For potential carcinogens, the risk to human health is expressed in terms of the probability of the chemical causing cancer over an estimated lifetime of 70 years. All risks estimated represent an "excess lifetime cancer risk" or the additional cancer risk on top of that which occur from other causes. EPA's risk management range for carcinogens is 1×10^{-4} to 1×10^{-6} (between a 1-in-10,000 and a 1-in-1,000,000 chance of developing cancer as a result of site-related exposure). In other words, if exposure to a particular carcinogenic chemical creates a 1-in-100,000 chance of causing cancer, then this would be expressed as 1×10^{-5} . In general, calculated risks greater than 1×10^{-4} require consideration of engineering-oriented cleanup alternatives. Cancer risks between 1×10^{-4} and 1×10^{-6} (between 1 in 10,000 and 1 in 1,000,000) fall within a risk management range that Redstone Arsenal risk managers may decide is acceptable on a case-by-case basis.

For noncarcinogens, the risk to human health is expressed as a hazard quotient (HQ) for each exposure pathway. The HQ is calculated by dividing the daily intake level by the appropriate exposure pathway RfD (e.g., oral RfD for ingestion pathway). The hazard index (HI) is the sum of all the HQs for all COPCs that affect the same target organ (e.g., liver) within or across those media to which the same individual may reasonably be exposed. An HI greater than 1 suggests that adverse health effects are possible.

Where cumulative risks have been found to exceed designated risk thresholds, chemicals with risks exceeding 1×10^{-6} (or an excess lifetime cancer risk of 1 in 1,000,000) or an HI of 0.1 may be selected as COCs. These are chemicals that significantly contribute to unacceptable risks for a pathway in an exposure model for a hypothetical receptor (e.g., a child that resides on the site). Typically, these selected chemicals represent chemicals which may require a response action. However, risk managers may refine the list of COCs selected for action based on site-specific considerations. Final identification of COCs may occur during a removal action or as part of the evaluations performed during the feasibility study for a site.

Risks presented in the RI report (Shaw, 2008a) from exposure to each medium and cumulative risk for each receptor after the NTCRA are shown in Table 3. As shown in Table 3, no receptors were found to have unacceptable risks from exposure to surface soil, subsurface soil, total soil or

surface water after the NTCRA was performed. As a result, no COCs were identified for surface soil, subsurface soil, total soil, or surface water.

As previously mentioned, there were no risks from exposure to spring water or groundwater because no COPCs were identified in these media. MSFC-002/087, however, is considered to be a surface media site, and potential risks from exposure to groundwater under this site will be addressed in the groundwater site RSA-149. In the interim, Redstone's and NASA's Installation-Wide Groundwater IRODs, signed in September 2007, also prevent the use of groundwater for potable purposes and ensure that any nonpotable uses of groundwater are reviewed and evaluated by the Army or NASA prior to being permitted (Shaw, 2007b; CH2M Hill, 2007). The remedial design document provides the specific implementation details for the groundwater interim land use controls at Redstone Arsenal (Shaw, 2007c).

Risks from TCE present in modeled concentrations of soil vapor that might migrate into indoor air and come in contact with a hypothetical future residential receptor exceeded the EPA (2002) target cancer risk level of 1×10^{-6} (1 in 1,000,000) but did not exceed the target risk levels of 1×10^{-5} (1 in 10,000) and 1×10^{-4} (1 in 10,000). The modeled indoor air concentration also falls below the target cancer risk levels of 1×10^{-6} (1 in 1,000,000), 1×10^{-5} (1 in 100,000) and 1×10^{-4} (1 case of cancer among 10,000 exposed persons) based on the California Environmental Protection Agency inhalation slope factor. The Department of Defense has determined that the California Environmental Protection Agency inhalation slope factor for TCE is the appropriate toxicity value to use in remedial determinations at Army facilities (U.S. Department of Defense, 2007).

As can be seen in Table 3, all cumulative risk estimates for all current and future receptors fell below the ADEM trigger level of 1×10^{-5} (1 in 100,000) (ADEM, 2007), which is interpreted to mean that there are no chemicals contributing to unacceptable risk for any receptor at MSFC-002/087.

2.7.1.5 Summary of the Baseline Human Health Risk Assessment

No contaminants in surface soil, subsurface soil, total soil, sediment, or surface water have been identified as COCs warranting additional action based on the results of the BHHRA after the NTCRA was performed. Chemicals in groundwater do not pose a human health threat if ingested, but these chemicals are being addressed during the RSA-149 groundwater site investigation. Risks to hypothetical future residential receptor from the vapor intrusion pathway do not exceed acceptable levels. No COCs were selected for MSFC-002/087 based on the results of the BHHRA.

2.7.2 Screening-Level Ecological Risk Assessment

The NTCRA addressed several COCs identified as posing a potential for adverse impacts to ecological receptors. The SLERA conducted for MSFC-002/087 after the NTCRA did not identify any contaminants in surface soil warranting additional action for ecological receptors. In addition, no chemicals of potential ecological concern (COPEC) identified in the surface water or sediments from the pond complex present at MSFC-002/087 have been shown to have the potential to pose adverse effects to populations of ecological receptor species that use this pond complex as a source of food and water. To reach this conclusion, the SLERA for MSFC-002/087 was completed in three steps, which are discussed below.

Step 1 – Screening-Level Problem Formulation and Toxicity Assessment. The primary objective of the ecological risk assessment is to evaluate whether individuals of species designated as having a special administrative status or populations of non-special-status species are potentially at risk when exposed to site-related chemicals at MSFC-002/087. The ecological receptors evaluated for this assessment included the following:

- Terrestrial plant and soil invertebrate communities
- Populations of mammals and birds which feed on soil invertebrates, plants, other animals, and fish
- Aquatic benthic invertebrate communities
- Aquatic water-column invertebrate and water-dwelling amphibian communities.

Two federally listed threatened or endangered species, the gray bat and Indiana bat (Army, 2005), could potentially be found as occasional visitors on this site or in the wetlands in the vicinity of MSFC-002/087. Although the bald eagle may also visit this site, this species was delisted as federally endangered or threatened in July 2007. NASA Spring is also located within the borders of the site in the southeastern part of MSFC-002/087. NASA Spring is considered a sensitive ecological habitat because of the presence of the Tuscumbia darter, a species of ecological concern. MSFC-002/087 also contains two types of listed ecological communities, wetland systems and aquatic systems.

For the other 17 special status species, one species identified as sensitive and monitored by the Alabama Natural Heritage Program is known to exist adjacent to MSFC-002/087. The Tuscumbia darter has been positively identified in NASA Spring and is routinely monitored from this location. An additional eight species identified as sensitive and monitored by the Alabama

Natural Heritage Program could potentially be found on MSFC-002/087, based on the habitat present in this area and taking into consideration the habitat requirements of the identified species. Species with the potential to be present on or in the vicinity of portions of MSFC-002/087 include the animal species American alligator, peregrine falcon, and solitary vireo and the plant species featherfoil (a submergent aquatic plant), pinesap (occurs in acidic rich woodlands), limestoneadder's tongue (a wetland fern), ginseng (occurs in rich hardwoods and into forested swamps), and dwarf trillium (known to occur in wooded swamps but not identified to date in Indian Creek wetland complexes). There are no reports that these species actually occur on or adjacent to MSFC-002/087. However, no surveys specific to MSFC-002/087 have been conducted to confirm or deny their presence.

As part of the NEPA documentation process required for federal actions, the Army regularly coordinates with the USFWS, the Alabama Natural Heritage Program, and the Alabama Department of Conservation and Natural Resources (Army, 2008b). The SLERA included in the Final RI report for MSFC-002/087 (Shaw, 2008a) discusses this coordination process in detail. As part of this coordination process, the Army has prepared an ESMP as required under 50 Code of Federal Regulations 402 (Army, 2005). This plan also includes the goals and objectives described within the U.S. Department of Defense Instruction 4517.3 and U.S. Army Regulation 200-3. The ESMP is reviewed annually and updated as needed.

Similar to the BHHRA, chemicals found in site soils, surface water, and sediment at concentrations above federal and state risk-screening levels (and background screening levels for metals) were identified as COPECs.

Step 2 – Screening-Level Exposure Estimate and Risk Calculation. Chemicals initially selected as COPECs in soil included several metals, one polychlorinated biphenyl (Aroclor 1260), several pesticides, and several PAHs. Chemicals initially selected as COPECs in surface water included several metals and cyanide. Chemicals initially selected as COPECs in sediment included several metals, cyanide, four pesticides, total PAHs, and two VOCs. Aluminum and cobalt were the only chemicals selected as COPECs in spring water (surface water collected from NASA Spring). Tables G-2 through G-5 of Appendix G of the RI report (Shaw, 2008a) presents the results of the selection of COPECs for surface soil, surface water, sediment, and spring water, respectively.

Step 3 – Problem Formulation Refinement. Further evaluations were performed during the problem formulation refinement step to determine whether adverse impacts individuals of special-status species and to populations of non-special status species present at this site would

be anticipated. This step consisted of three parts: an assessment of exposure, toxicity, and risk characterization. The exposure assessment was based on measured concentrations of COPECs in site surface soils, surface water, sediment, and spring water. These concentrations were used directly to assess the potential for adverse impacts to plants and soil invertebrates, aquatic benthic invertebrates, and aquatic water-column-dwelling invertebrates and vertebrates from exposure to contaminants in site-related media.

Food-chain dose calculations were performed using appropriate bioaccumulation factors to estimate chemical concentrations in the food of mammals and birds of various trophic guilds which feed in the terrestrial area and ponds on this site. Metals that did not exceed background screening values were excluded from these analyses. For food-chain receptors, doses of chemicals were developed on a per-body mass basis.

Toxicity endpoint concentrations for soil, plant, or invertebrate communities were based on literature-derived soil, surface water, and sediment concentrations identified as posing potential impacts to plants or soil invertebrates. For food-chain receptors, toxicity reference values used in the SLERA were based on studies where both no observable adverse effects levels and lowest observable adverse effects levels were determined. The risk characterization was performed by calculating an HQ. The HQ is defined as the exposure (soil, surface water, or sediment concentration or dose) divided by the toxicity endpoint concentration. If the HQ is greater than 1.0, a potential adverse impact may occur for particular species. Tables G-24 through G-26 included in Appendix G of the RI report present the results of the comparison to literature-based toxicity values for plants/soil invertebrates and aquatic organisms, while Tables G-27 and G-28 present the summary of HQs for food chain receptors for soils and ponds (Shaw, 2008a). These results are summarized and presented in Tables 4 and 5 of this ROD.

Based on this SLERA, no COPECs in soil were identified as posing potential impacts to terrestrial communities of plants or soil invertebrates. Some uncertainty exists in this conclusion because alternative screening values were lacking to evaluate potential impacts to these receptors from pesticides or to plant communities for PAHs. However, the removal action in 2007 has significantly reduced concentrations of these chemicals compared to pre-removal concentrations, which has minimized the potential for adverse impacts to community-based receptors.

No COPECs in surface water were identified as posing potential impacts to aquatic community-based ecological receptors.

No COPECs warranting further evaluation for food chain receptors were identified for the surface soil or for surface water or sediments from the pond complex present at MSFC-002/087.

2.7.3 Risk Summary

No contaminants in surface media have been identified as COCs or COPECs warranting additional action based on the results of the conservative exposure scenarios in the BHHRA and SLERA, respectively. Additionally, chemicals in groundwater do not pose a human health threat and further evaluation of the groundwater will be conducted with the RSA-149 groundwater site.

2.7.4 Basis for Action

An NFA remedy has been selected for MSFC-002/087 surface media. The characterization that was performed at this site after the NTCRA supports this selection (see Section 2.5 for site characteristics). Based on the results of the fate and transport analysis, no chemicals detected on site were found to pose a leaching threat to groundwater (see Section 2.5.4 for fate and transport). In addition, the NTCRA addressed the potential for contamination in soils to act as an ongoing source of contamination to the surface water bodies and wetlands located adjacent to MSFC-002/087. This ROD documents that the MSFC-002/087 surface media do not pose unacceptable risks to human health or the environment under current or future industrial or future unrestricted exposure scenarios (see Section 2.7 for site risks). Current guidelines from EPA and ADEM state that "unrestricted use," including residential land use, must be considered in a No Further Action decision. The risk assessments performed for MSFC-002/087 support the finding that surface media at MSFC-002/087 are available for unrestricted use.

Several rounds of sampling have been performed at this site for all media, including the overburden groundwater. The evaluation of groundwater does not indicate a source of contamination at the site and the contaminants in groundwater were determined to not pose a human health threat. The groundwater will undergo a final assessment in the groundwater site RSA-149 remedial investigation.

In summary, an NFA remedy has been selected as the final remedy for surface media at MSFC-002/087. An NTCRA was conducted for surface and shallow subsurface soil contaminated with DDT and its metabolites and PAHs to address the environmental threats at the site. Following this action, it was determined that no additional action (CERCLA or RCRA) is required for the surface media at the site, including long-term monitoring or land-use controls. No additional evaluation of remedial alternatives is required when an NFA remedy is selected for a site.

The selected alternative of NFA is protective of human health and the environment and complies with applicable requirements, including requirements under CERCLA and corrective action requirements under RCRA. Therefore, it is the Army's current judgment that no additional remedial action is necessary at this site to ensure protection of public health, welfare, or the environment, from actual or threatened releases of hazardous substances into the environment.

2.8 Documentation of Significant Changes

No significant change has been made to the Preferred Alternative presented in the SB/PP (Shaw, 2008c).

3.0 Responsiveness Summary

The Responsiveness Summary serves three primary purposes. First, it provides the Army, EPA, and ADEM with information about community concerns with the site and preferences about the Preferred Alternative presented in the SB/PP (Shaw, 2008c). Second, it shows how the public's comments were factored into the decision-making process for selection of the final remedy. Third, it provides a formal mechanism for the Army to respond to public comments.

This Responsiveness Summary documents the formal public comments received on the MSFC-002/087 SB/PP (Shaw, 2008c) during the April 2 to May 1, 2008 public comment period and the Army's responses to the comments. The following comments were received in writing on the SB/PP. No identification of the author of the comments is provided here.

Comment 1: Reference page 2-3, last paragraph. What happened to the material that was removed from the 5 locations during the NTCRA? Some reference to the final disposal should be included in this report.

Army Response 1: The material that was removed from debris piles at MSFC-002/087 was classified as nonhazardous Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) waste based on its site history and analytical data. The soil was disposed at the Allied Subtitle D Landfill in Hillsboro, Alabama as approved by the Alabama Department of Environmental Management (ADEM). The details of the disposal are presented in Section 2.4 and Appendix D of the Final Closure Report for the Non-Time-Critical Removal Action at MSFC-002/087: Inactive Abandoned Drum Disposal Site/Inactive Cyanide Lagoon, Operable Unit 18, Redstone Arsenal, Madison County, Alabama, Revision 1 (Shaw, February 2008). This record of decision (ROD) for MSFC-002/087 also includes reference (Section 2.2.3) to the final disposal of the waste from the Non-Time-Critical Removal Action.

Comment 2: Reference page 3-4, Paragraph 3.2. Has the Olin DDT Remedial Action Review Panel been informed of the data and results of this report? The POC on Redstone Arsenal for this Panel is Mr. Danny Dunn of the Environmental Management Division. Some reference or statement to this effect should be included in this report.

Army Response 2: It is unknown whether the Olin DDT Remedial Action Review Panel has been informed of the data and the results of Final Closure Report for the Non-Time Critical Removal Action at MSFC-002/087 (Shaw, February 2008). Electronic versions of documents regarding the NTCRA can be reviewed at Redstone Arsenal or at the Huntsville-Madison County and the Triana Public Libraries or obtained electronically from the Army by

emailing the request to EnvironmentalOffice@redstone.army.mil. The presence of localized hot spots of DDT and polynuclear aromatic hydrocarbon (PAH) contamination in the debris piles at MSFC-002/087 is not related to the Olin DDT Remedial Action Program conducted at Olin's former manufacturing areas, drainage areas, and disposal landfills at Redstone Arsenal. Therefore, the Olin DDT Remedial Action Review Panel is not discussed in this Final ROD.

4.0 References

Alabama Department of Environmental Management (ADEM), 2007, *Alabama Risk-Based Corrective Action Guidance Manual*, June.

A.T. Kearney, 1989, *Interim RCRA Facility Assessment of the RSA, Huntsville, Alabama*, prepared for the U.S. Environmental Protection Agency, September.

California Environmental Protection Agency, 2002, *Air Toxics Hot Spot Program Risk Assessment Guidelines, Part II, Technical Support for Describing Available Cancer Potency Factors*, December.

CH2M Hill, 2007, *Final Interim Record of Decision, Interim Action Project for Operable Unit 3: Groundwater at Marshall Space Flight Center*, prepared for the National Aeronautics and Space Administration Marshall Space Flight Center, September.

CH2M Hill, 1999, *Final MSFC Surface Media Remedial Investigation Report, Operable Units 1, 5, 6, 7, and 8, Volumes I-IV, Prepared for National Aeronautics and Space Administration (NASA), Marshall Space Flight Center (MSFC), Huntsville, Alabama*, March.

CH2M Hill, 1997, *Final MSFC Surface Media Remedial Investigation (RI) Report, Operable Units 1, 5, 6, 7, and 8, Volumes 1 – 5*, prepared for National Aeronautics and Space Administration (NASA), Marshall Space Flight Center (MSFC), Huntsville, Alabama, March.

Geraghty & Miller, Inc., 1991, *Final Identification and Evaluation of Potential Solid Waste Management Units and Areas of Concern*, prepared for the U.S. Army Corps of Engineers, February.

Harmon Engineering Associates, Inc., 1989, *Preliminary Assessment of CERCLA Candidate Sites and Related Sites of Possible Environmental Significance, Marshall Space Flight Center, Huntsville Alabama*, prepared for George C. Marshall Space Flight Center, Alabama, February.

Johnson, P.C. and R. A. Ettinger, 1991, *Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors in Buildings*, Environ. Sci. Technol. 25: 1445-1452.

National Aeronautics and Space Administration (NASA), 2005, *Supplement to "Memorandum of Agreement (MOA) Between the U.S. Army Missile Command and Marshall Space Flight Center (MSFC)"* dated December 20, 1994, Memorandum from David A. King, Director, to Colonel Robert J. Devlin, U.S. Army Garrison – Redstone (Army), 14 February.

Rust Environment & Infrastructure, Inc., 1998, *Draft-Final Site Screening Remedial Investigation Report for RSA-64, -69, and -70, MSFC-2, -3, -27, -34, -53, -55, -60, -65, -74, -77, and -82, Redstone Arsenal, Madison County, Alabama, Revision 1*, prepared for U.S. Army Corps of Engineers, Savannah District, October.

Shaw Environmental, Inc. (Shaw), 2008a, ***Final Remedial Investigation Report, Baseline Human Health Risk Assessment, and Screening-Level Risk Assessment for MSFC-002/087: Inactive Abandoned Disposal Site/Inactive Cyanide Lagoon, Operable Unit 18, Redstone Arsenal, Madison County, Alabama***, prepared for the U.S. Army Corps of Engineers, Savannah District, April.

Shaw Environmental, Inc. (Shaw), 2008b, ***Final Closure Report for the Non-Time-Critical Removal Action at MSFC-002/087: Inactive Abandoned Disposal Site/Inactive Cyanide Lagoon, Operable Unit 18, Redstone Arsenal, Madison County, Alabama***, prepared for the U.S. Army Corps of Engineers, Savannah District, February.

Shaw Environmental, Inc. (Shaw), 2008c, ***Final Statement of Basis/Proposed Plan for Surface Media at MSFC-002/087: Inactive Abandoned Disposal Site/Inactive Cyanide Lagoon, Operable Unit 18, Redstone Arsenal, Madison County, Alabama, Revision 1***, prepared for the U.S. Army Corps of Engineers, Savannah District, March.

Shaw Environmental, Inc. (Shaw), 2008d, ***Redstone Arsenal Fact Sheet 24, Non-Time-Critical Removal Action at MSFC-002/087***, Environmental Management Division, prepared for the U.S. Army Corps of Engineers, Savannah District, January.

Shaw Environmental, Inc. (Shaw), 2007a, ***Redstone Arsenal Fact Sheet 25, Regrouping of Redstone Arsenal Installation Restoration Program Sites for Streamlining Site Cleanup***, Environmental Management Division, prepared for the U.S. Army Corps of Engineers, Savannah District, October.

Shaw Environmental, Inc. (Shaw), 2007b, ***Final Interim Record of Decision, Interim Remedial Action for Installation-Wide Groundwater, Redstone Arsenal, Madison County, Alabama***, prepared for the U.S. Army Corps of Engineers, Savannah District, September.

Shaw Environmental, Inc. (Shaw), 2007c, ***Draft Installation-Wide Groundwater Land-Use Control Remedial Design, Redstone Arsenal, Madison County, Alabama***, prepared for the U.S. Army Corps of Engineers, Savannah District, December.

Shaw Environmental, Inc. (Shaw), 2006, ***Community Relations Plan, Redstone Arsenal, Madison County, Alabama***, prepared for the U.S. Army Corps of Engineers, Savannah District, March.

Shaw Environmental, Inc. (Shaw), 2003, ***Final Sitewide Karst Hydrogeologic Investigation, Phase I Report of Findings, Redstone Arsenal, Madison County, Alabama***, Volumes 1 and 2, prepared for the U.S. Army Corps of Engineers, Savannah District, May.

U.S. Army Garrison - Redstone (Army), 2008a, ***Redstone Arsenal Army Defense Environmental Restoration Program Installation Action Plan***, January.

U.S. Army Garrison – Redstone (Army) 2008b, Personal Communication, Shannon Allen, Redstone Garrison staff ecologist, January 15.

U.S. Army Garrison – Redstone (Army), 2006a, *Redstone Arsenal Environmental Site Access Control Program*, June.

U.S. Army Garrison – Redstone (Army), 2006b, *Real Property Master Plan Digest*.

U.S. Army Garrison – Redstone (Army), 2005, *Endangered Species Management Plan*.

U.S. Army Garrison – Redstone (Army), 1994, “Memorandum of Agreement (MOA) Between the U.S. Army Missile Command and Marshall Space Flight Center (MSFC)”, Memorandum from James M. Link, Major General, to G. Porter Bridwell, Director, Marshall Space Flight Center, 20 December.

U.S. Department of Defense, 2007, *Identification and Selection of Toxicity Values/Criteria for CERCLA and Hazardous Waste Site Risk Assessments in the Absence of IRIS Values*, ECOS-DoD Sustainability Work Group’s Emerging Contaminants Task Group, April 23.

U.S. Environmental Protection Agency (EPA), 2004a, *Region 9 PRG Table*, San Francisco, California, October.

U.S. Environmental Protection Agency (EPA), 2004b, *Users Guide for Evaluating Subsurface Vapor Intrusion into Buildings*, Office of Emergency and Remedial Response, Washington, D.C., February 22.

U.S. Environmental Protection Agency (EPA), 2002, *Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils [Subsurface Vapor Intrusion Guidance]*, Office of Solid Waste, EPA 530-F-02-052, November.

U.S. Environmental Protection Agency (EPA), 2001, *Trichloroethylene Health Risk Assessment: Synthesis and Characterization Report (External Review Draft)*, Office of Research and Development, National Center for Environmental Assessment (NCEA), Washington Office, Washington, DC, EPA/600/P-01/002A.

U.S. Environmental Protection Agency (EPA), 1991a, *A Guide to Principal Threat and Low Level Threat Wastes*, 9380.3-06FS, Office of Solid Waste and Emergency Response, November.

U.S. Environmental Protection Agency (EPA), 1991b, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*, Directive 9355.0-30, Office of Solid Waste and Emergency Response, April.

TABLES

Table 1

**Surface Soil Data Summary
Before and After the Non-Time-Critical Removal Action
MSFC-002/087
Redstone Arsenal, Madison County, Alabama**

SUMMARY OF RESULTS BEFORE THE NTCRA

Chemical	Unit	Frequency of Detection	Detected Concentrations				Arithmetic Average	95% UCL	Exposure Point Concentration	Basis of Exposure Point Concentration
			Minimum Value	VQ	Maximum Value	VQ				
4,4'-DDE	mg/kg	35 / 54	0.00026	J	2.4	J	1.05E-01	3.29E-01	3.29E-01	95% UCL
4,4'-DDT	mg/kg	33 / 54	0.0005	J	23		9.31E-01	3.27E+00	3.27E+00	95% UCL
Benzo(a)anthracene	mg/kg	20 / 67	0.0021	J	27		7.53E-01	2.52E+00	2.52E+00	95% UCL
Benzo(a)pyrene	mg/kg	20 / 67	0.0088		21		6.43E-01	2.02E+00	2.02E+00	95% UCL
Benzo(b)fluoranthene	mg/kg	22 / 67	0.0025	J	16		5.67E-01	1.62E+00	1.62E+00	95% UCL
Benzo(k)fluoranthene	mg/kg	21 / 67	0.0036	J	19		5.91E-01	1.83E+00	1.83E+00	95% UCL
Dibenz(a,h)anthracene	mg/kg	7 / 67	0.016		3.7		2.60E-01	5.02E-01	5.02E-01	95% UCL
Indeno(1,2,3-cd)pyrene	mg/kg	18 / 67	0.0091		14		4.80E-01	1.39E+00	1.39E+00	95% UCL

SUMMARY OF RESULTS AFTER THE NTCRA

Chemical	Unit	Frequency of Detection	Detected Concentrations				Arithmetic Average	95% UCL	Exposure Point Concentration	Basis of Exposure Point Concentration
			Minimum Value	VQ	Maximum Value	VQ				
4,4'-DDE	mg/kg	35 / 54	0.00026	J	0.41	J	3.92E-02	NA	NA	NA
4,4'-DDT	mg/kg	33 / 54	0.0005	J	1		8.96E-02	NA	NA	NA
Benzo(a)anthracene	mg/kg	22 / 68	0.0021	J	0.91		2.35E-01	3.14E-01	3.14E-01	95% UCL
Benzo(a)pyrene	mg/kg	22 / 68	0.0088		0.92	J	2.22E-01	2.96E-01	2.96E-01	95% UCL
Benzo(b)fluoranthene	mg/kg	24 / 68	0.0025	J	1.1	J	2.33E-01	3.39E-01	3.39E-01	95% UCL
Benzo(k)fluoranthene	mg/kg	23 / 68	0.0036	J	0.78	J	2.19E-01	NA	NA	NA
Dibenz(a,h)anthracene	mg/kg	9 / 68	0.016		0.13		1.78E-01	1.11E-01	1.11E-01	95% UCL
Indeno(1,2,3-cd)pyrene	mg/kg	20 / 68	0.0091		0.65	J	2.08E-01	2.59E-01	2.59E-01	95% UCL

95% UCL - 95 Percent upper confidence limit.

J - The compound/analyte was positively identified; the reported result is the estimated concentration of the compound/analyte detected in the sample analyzed.

NA - Not applicable; chemical was not identified as a chemical of potential concern and was not evaluated further in the risk assessment.

NTCRA - Non-time-critical removal action.

VQ - Validation qualifier.

mg/kg - Milligrams per kilogram.

Table 2

**Subsurface Soil Data Summary
Before and After the Non-Time-Critical Removal Action
MSFC-002/087
Redstone Arsenal, Madison County, Alabama**

SUMMARY OF RESULTS BEFORE THE NTCRA

Chemical	Unit	Frequency of Detection	Detected Concentrations				Arithmetic Average	95% UCL	Exposure Point Concentration	Basis of Exposure Point Concentration
			Minimum Value	VQ	Maximum Value	VQ				
4,4'-DDT	mg/kg	16 / 32	0.0003	J	7.4		2.37E-01	1.24E+00	1.24E+00	95% UCL
Benzo(a)anthracene	mg/kg	6 / 50	0.002	J	9		4.40E-01	1.25E+00	1.25E+00	95% UCL
Benzo(a)pyrene	mg/kg	4 / 50	0.29	J	7.4		4.03E-01	1.08E+00	1.08E+00	95% UCL
Benzo(b)fluoranthene	mg/kg	6 / 50	0.0022	J	7.4		4.03E-01	1.08E+00	1.08E+00	95% UCL
Dibenz(a,h)anthracene	mg/kg	2 / 50	0.67		1.5		2.11E-01	3.40E-01	3.40E-01	95% UCL
Indeno(1,2,3-cd)pyrene	mg/kg	5 / 50	0.0034	J	3.4		2.85E-01	5.99E-01	5.99E-01	95% UCL

SUMMARY OF RESULTS AFTER THE NTCRA

Chemical	Unit	Frequency of Detection	Detected Concentrations				Arithmetic Average	95% UCL	Exposure Point Concentration	Basis of Exposure Point Concentration
			Minimum Value	VQ	Maximum Value	VQ				
4,4'-DDT	mg/kg	16 / 32	0.0003	J	0.37	U-	1.82E-02	NA	NA	NA
Benzo(a)anthracene	mg/kg	6 / 50	0.002	J	0.59	J	1.92E-01	NA	NA	NA
Benzo(a)pyrene	mg/kg	4 / 50	0.27	J	0.32	J	1.83E-01	2.28E-01	2.28E-01	95% UCL
Benzo(b)fluoranthene	mg/kg	6 / 50	0.0022	J	0.44	J	1.90E-01	NA	NA	NA
Dibenz(a,h)anthracene	mg/kg	3 / 50	0.05875	UJ-J	0.13		1.70E-01	NA	NA	NA
Indeno(1,2,3-cd)pyrene	mg/kg	5 / 50	0.0034	J	0.3	J	1.80E-01	NA	NA	NA

95% UCL - 95 Percent upper confidence limit.

J - The compound/analyte was positively identified; the reported result is the estimated concentration of the compound/analyte detected in the sample analyzed.

NA - Not applicable; chemical was not identified as a chemical of potential concern and was not evaluated further in the risk assessment.

NTCRA - Non-time-critical removal action.

U - Validation qualifier of "U-" indicates that one or more of the results included in the averaging was a nondetect.

Average result is considered a detect.

VQ - Validation qualifier. When a detected concentration is the result of averaging multiple results, a compilation of the qualifiers for each result included in the averaging is presented and separated by a hyphen (e.g., U-J-).

mg/kg - Milligrams per kilogram.

Table 3

**Total Cancer Risks and Noncancer Hazards for Current and Future Site Receptors
After the Non-Time-Critical Removal Action
MSFC-002/087
Redstone Arsenal, Madison County, Alabama**

Receptors	Current Site Use	Future Site Use		
	Soil and Surface Water ^a	Soil and Surface Water ^a	Groundwater (Potable Source)	Total Risk
CANCER RISK				
Industrial Receptors:				
Groundskeeper (Conventional) ^b	1.28×10^{-6}	1.28×10^{-6}	NQ	1.28×10^{-6}
Groundskeeper (Alternative) ^c	NE	1.04×10^{-6}	NQ	1.04×10^{-6}
Construction Worker (Conventional) ^b	2.82×10^{-8}	2.82×10^{-8}	NQ	2.82×10^{-8}
Construction Worker (Alternative) ^c	NE	1.60×10^{-7}	NQ	1.60×10^{-7}
Recreational Receptors:				
Sportsman	NE	1.95×10^{-7}	NE	1.95×10^{-7}
Trespasser	7.62×10^{-8}	7.62×10^{-8}	NE	7.62×10^{-8}
Hypothetical Residential Receptor:				
Lifetime (Conventional) ^b	NE	8.09×10^{-6}	NQ	8.09×10^{-6}
Lifetime (Alternative) ^c	NE	6.62×10^{-6}	NQ	6.62×10^{-6}
NONCANCER HAZARD ^d				
Industrial Receptors:				
Groundskeeper (Conventional) ^b	0.078	0.078	NQ	0.078
Groundskeeper (Alternative) ^c	NE	0.072	NQ	0.072
Construction Worker (Conventional) ^b	0.108	0.108	NQ	0.108
Construction Worker (Alternative) ^c	NE	0.851	NQ	0.851
Recreational Receptors:				
Sportsman	NE	0.145	NE	0.145
Trespasser	0.114	0.114	NE	0.114
Hypothetical Residential Receptor:				
Child (Conventional) ^b	NE	1.13^e	NQ	1.13^e
Child (Alternative) ^c	NE	1.05^e	NQ	1.05^e

NE - Not evaluated.

NQ - Not quantified; no chemicals of potential concern were identified in groundwater; therefore, exposure to groundwater is not quantified.

^a Includes cancer risks and noncancer hazards from exposure to the following media and receptors:

Surface soil - groundskeeper, construction worker, sportsman, trespasser, and hypothetical residential receptor.

Subsurface soil - construction worker.

Surface water - sportsman and trespasser.

Total soil - groundskeeper, construction worker, and hypothetical residential receptor.

No chemicals of potential concern were identified in spring water or shallow groundwater. Therefore, cancer risks and noncancer hazards were not quantified for these media.

Exposure to sediment perennially covered with water is generally insignificant and therefore is not quantified.

^b Conventional - Exposure to surface soil except for construction worker where exposure is to surface soil and subsurface soil.

^c Alternative - Total soils. Total soil hypothetically assumes surface and subsurface soil are mixed during future development.

^d The noncancer hazard is expressed as a hazard index.

^e Although the noncancer hazard for this receptor exceeds the threshold of 1, no target organ hazard index exceeds 1.

Table 4

**Summary of Screening-Level Ecological Risk Evaluation Results for Terrestrial Receptors
After the Non-Time-Critical Removal Action
MSFC-002/087
Redstone Arsenal, Madison County, Alabama**

Step 3a COPEC	Results of Food Chain Modeling				Results of Plant & Earthworm Community Analysis- Mean HQ over 1	Retain as a COC?	Rationale Code
	Max-NOAEL HQ greater than 1	Max-LOAEL HQ over 1	Mean-NOAEL HQ greater than 1	Mean- LOAEL HQ over 1			
Aluminum	X	X	X	X	X	N	BKG
Cadmium	X					N	Low HQs
Chromium III	X	X	X		X	N	BKG
Chromium VI	X				X	N	BKG
Lead	X	X	X			N	Low HQs
Mercury					X	N	Low HQs
Selenium	X	X				N	Low HQs
Vanadium	X	X	X			N	BKG
Zinc	X	X	X		X	N	Low HQs
Total PAHs	X		X		X	N	Low HQs
4,4'-DDE	X	X			NSV	N	Low HQs
4,4'-DDT	X	X	X		NSV	N	Low HQs
Endosulfan II	X				NSV	N	Low HQs
Endrin	X					N	Low HQs
Endrin aldehyde	X					N	Low HQs
Heptachlor epoxide	X				NA	N	Low HQs
Total DDD/DDE/DDT	X	X	X		NSV	N	Other
Total Endosulfans	X				NA	N	Low HQs
Total Endrins	X				NSV	N	Low HQs
Total Heptachlors	X				NA	N	Low HQs

Notes:

X - Range of HQ based on the results of the screening-level ecological risk assessment.

HQ - Hazard quotient based on mean or maximum concentration compared to toxicity reference value.

LOAEL - Lowest-observed-adverse-effect level.

NOAEL - No-observed-adverse-effect level.

Max - Maximum detected value.

Mean - Arithmetic average concentration.

COPEC - Chemical of potential ecological concern.

COC - Chemical of concern.

NSV - No screening value available.

N - COPEC is not retained as a COC.

NA - HQ_{screen} values were below 1.0; therefore no community analysis was conducted.

Rationale Codes:

BKG - Background related.

Low HQs - HQs were less than 1 for most receptors and did not exceed 10 for any receptor.

Other - Mean LOAEL HQs are less than 1 for all receptors. Only one receptor had a Max-NOAEL slightly greater than 10.

Therefore, no population level impacts would be expected.

Table 5

**Summary of Screening-Level Ecological Risk Evaluation Results for Aquatic Receptors
After the Non-Time-Critical Removal Action**

MSFC-002/087

Redstone Arsenal, Madison County, Alabama

Step 3a COPEC	Results of Food Chain Modeling				Results of Aquatic Community Analysis- Mean HQ over 1	Retain as a COC?	Rationale Code
	Max-NOAEL HQ greater than 1	Max-LOAEL HQ over 1	Mean-NOAEL HQ greater than 1	Mean- LOAEL HQ over 1			
Aluminum	X	X	X	X	X	N	Low HQs
Arsenic	X		X		NA	N	Low HQs
Cadmium	X		X		X	N	Low HQs
Chromium VI	X					N	Low HQs
Lead	X	X				N	Low HQs
Methylmercury	X	X	X	X		N	Other 1
Selenium	X	X	X	X		N	Low HQs
Zinc	X	X	X			N	Max
Copper					X	N	Low HQs
Manganese					X	N	NSR
Total Cyanide	X				X	N	ANAL
DDD					X	N	Low Conc
DDE					X	N	Low Conc
DDT	X				X	N	Low Conc
Total DDD/DDE/DDT	X				X	N	Low Conc

Notes:

X - Range of HQ based on the results of the screening-level ecological risk assessment.

HQ - Hazard quotient based on mean or maximum concentration compared to toxicity reference value.

LOAEL - Lowest-observed-adverse-effect level.

NOAEL - No-observed-adverse-effect level.

Max - Maximum detected value.

Mean - Arithmetic average concentration.

COPEC - Chemical of potential ecological concern.

COC - Chemical of concern.

NSV - No screening value available.

N - COPEC is not retained as a COC.

Rationale Codes:

ANAL - Current data indicate that elevated values in historical samples cannot be confirmed.

Max - Only maximum but not average exposure point concentrations resulted in HQs over 10 for food chain receptors.

Elevated concentrations were not sufficiently wide-spread to result in population-level impacts.

NSR - Not site related; there is no known site-related release of manganese, and no indication of manganese contamination in any other site media.

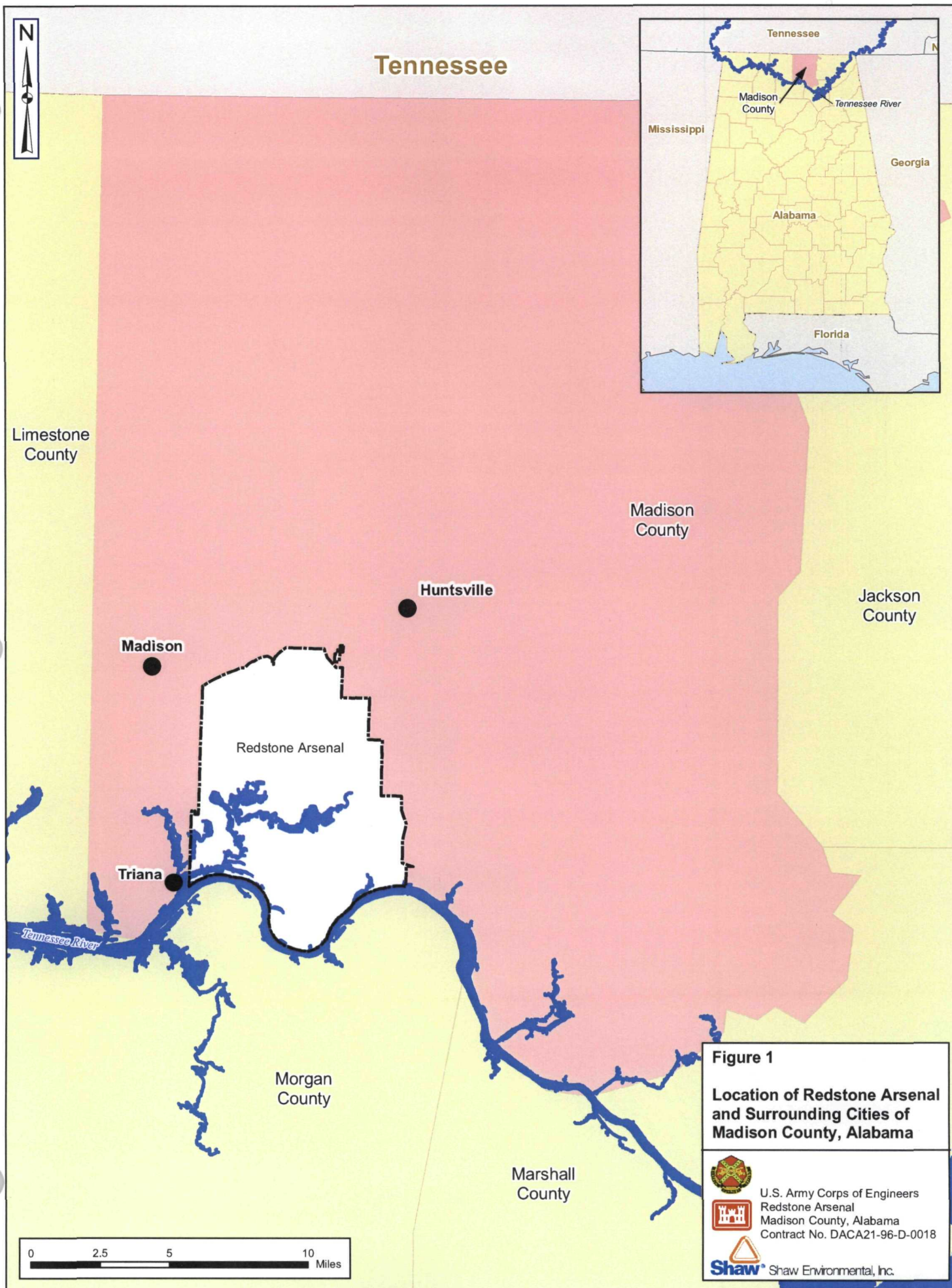
Low HQs - HQs were less than 1 for most receptors and did not exceed 10 for any receptor.

Low Conc - Low concentrations; while there is no approved anthropogenic background value for these chemicals, the max concentration of these chemicals is lower than some reference concentrations for sediment samples collected at stream entry points to Redstone Arsenal along Huntsville Spring Branch.

Other 1 - HQs were calculated assuming that 100% of mercury was methylmercury.

This assumption is highly unlikely.

FIGURES



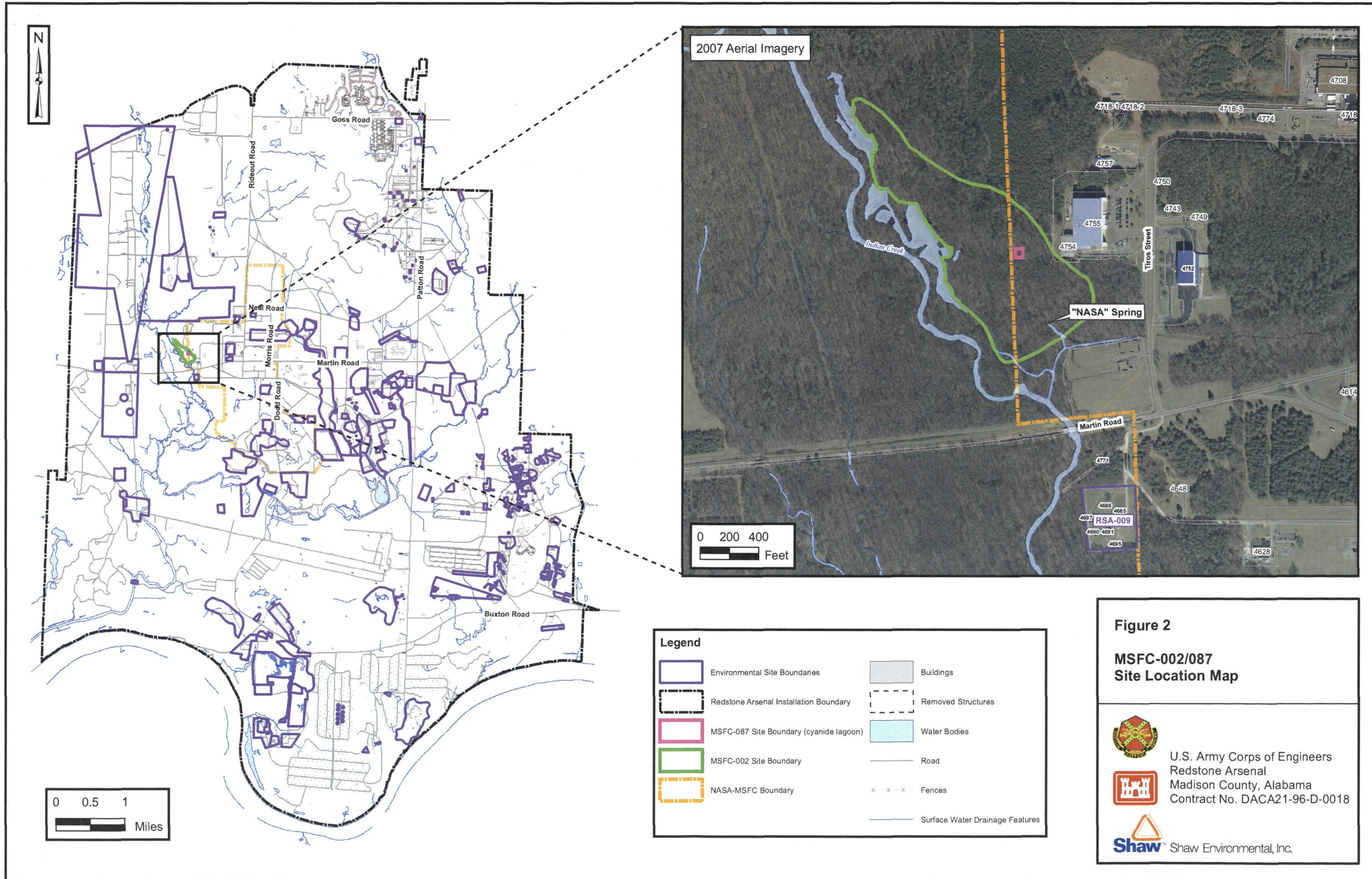


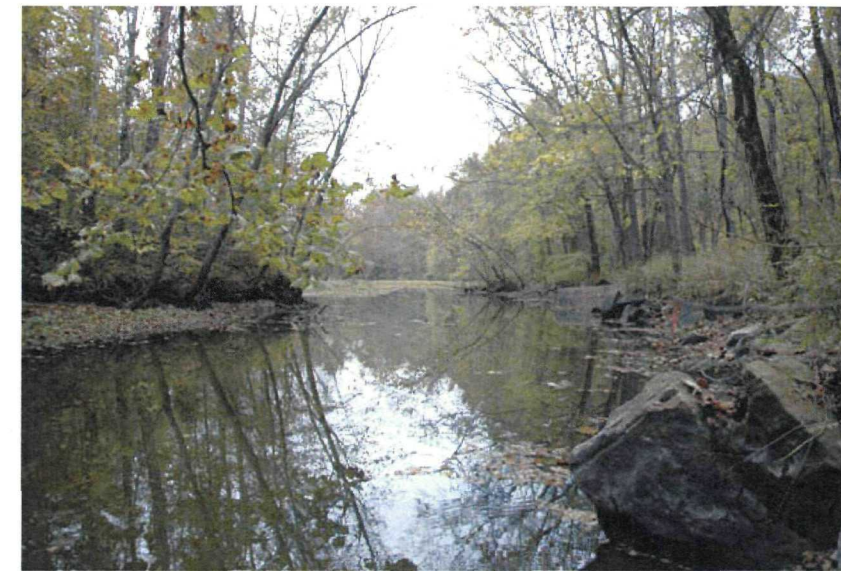
Figure 2
MSFC-002/087
Site Location Map

 U.S. Army Corps of Engineers
 Redstone Arsenal
 Madison County, Alabama
 Contract No. DACA21-96-D-0018

 Shaw Environmental, Inc.



Typical Construction Debris – MSFC-002



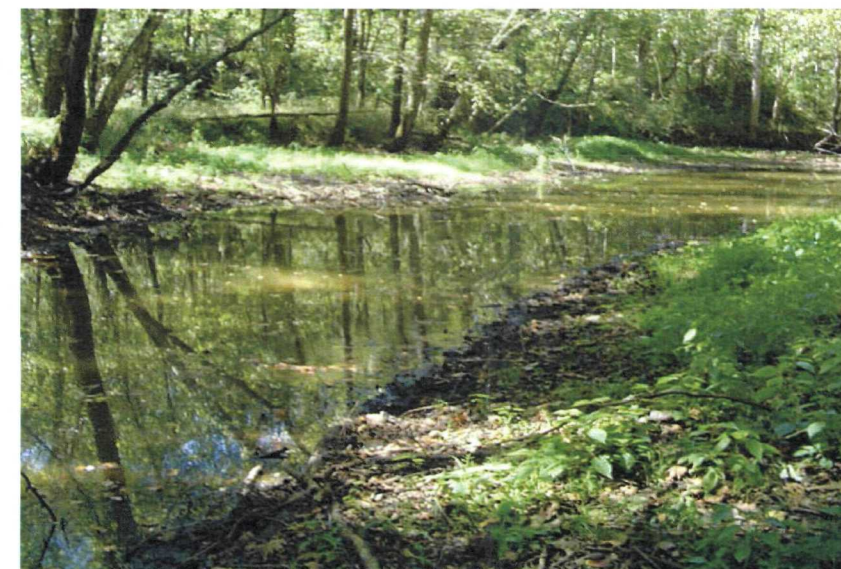
Central Ponds Area in Northwest Direction



Typical Construction Debris – MSFC-002



Typical Construction Debris – MSFC-002



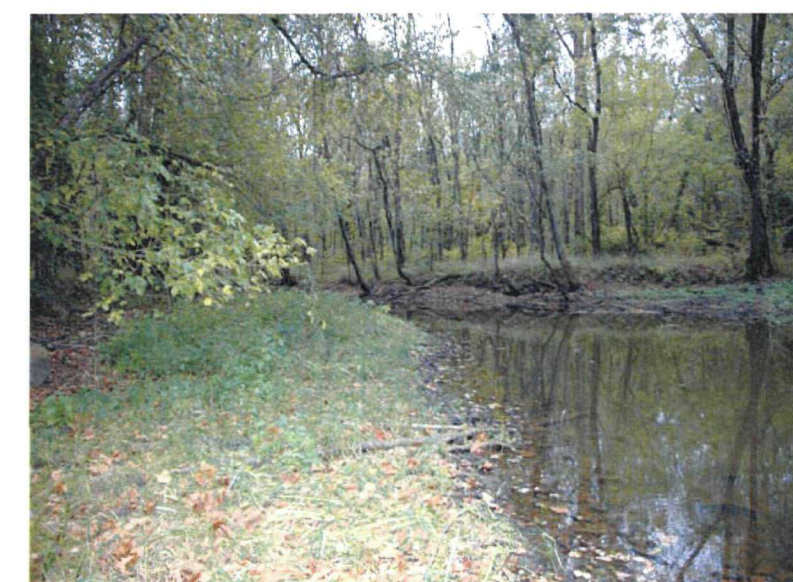
Southern Pond in Northwest Direction



Northern Pond Northwest of Monitoring Well T2-RS896



Typical Construction Debris Along Eastern Shore of Ponds – MSFC-002



Southern Pond Area in Southwest Direction

Figure 3

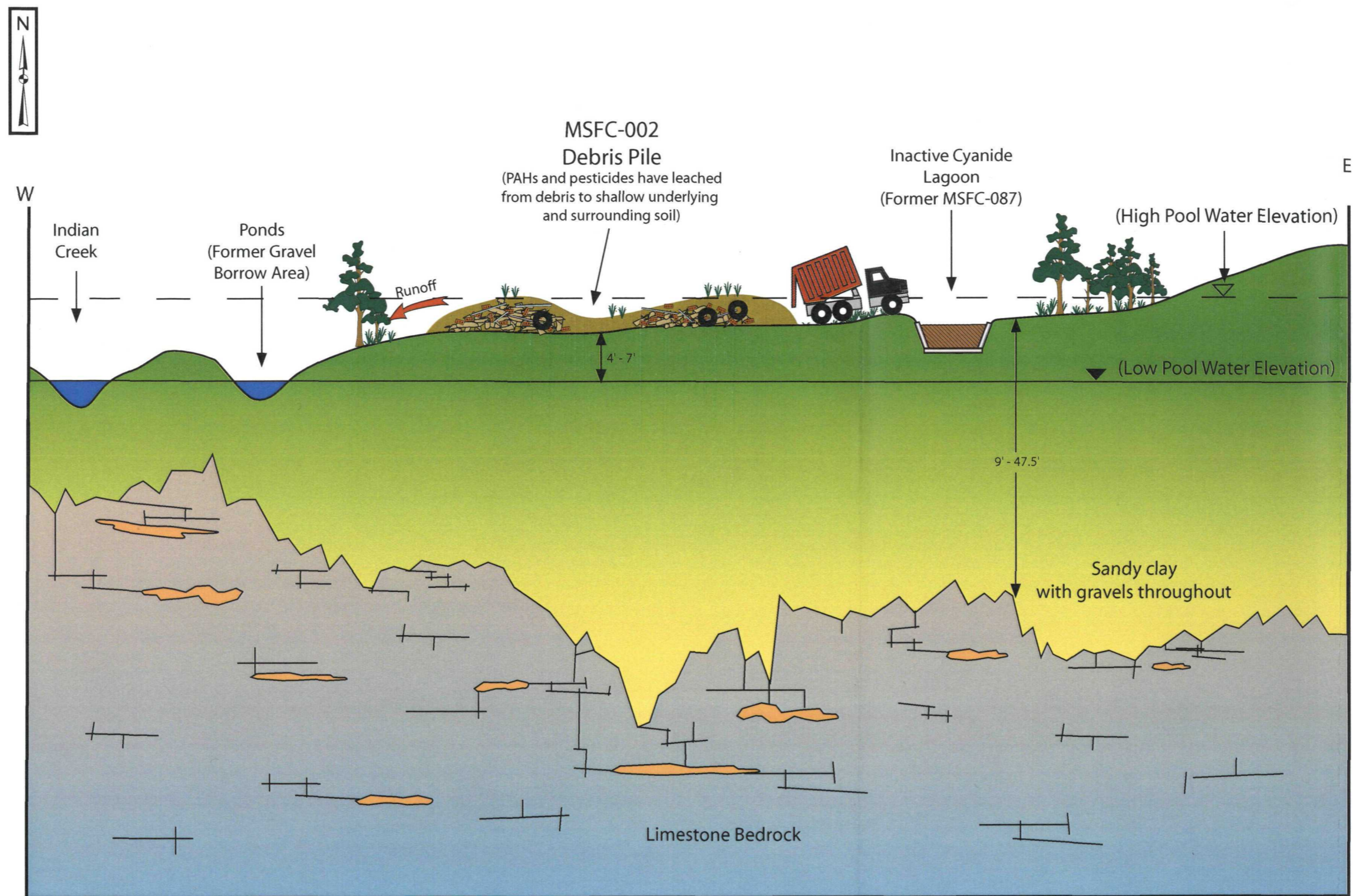
MSFC-002/087 Photos



U.S. Army Corps of Engineers
Redstone Arsenal
Madison County, Alabama
Contract No. DACA21 96-D-0010



Shaw Environmental, Inc.



- PAHs have been detected in soil as a result of the disposal of construction-related wastes (e.g., concrete slabs) in debris piles at the site. PAHs are relatively immobile in soil and are not leaching to groundwater.
- Pesticides have been detected in soil at the debris piles presumably from the disposal of general waste containing residual DDT and other pesticides. Pesticides were also detected ubiquitously throughout the site presumably from the past legal application to control the insect population (e.g., mosquitoes) at the site. Pesticides are essentially immobile in the soil and do not leach to groundwater.
- Concentrations of potential volatile organic compounds in soil vapor were modeled for the site and pose no unacceptable health threat to any receptor.

- A non-time-critical removal action was conducted in 2007 at several debris piles to remove soil/debris present at concentrations above the target cleanup levels. Subsequent to the removal action, exposure to the soils alone (and groundwater) poses no threat to any receptor from site-related chemicals.
- Surface runoff presents a minor migration pathway for surface soil PAHs and pesticides. However, PAHs and pesticides were not detected in surface water in the ponds.
- No adverse impacts to populations of non-special status species that reside at or use the site are anticipated.

Not to scale

Figure 4

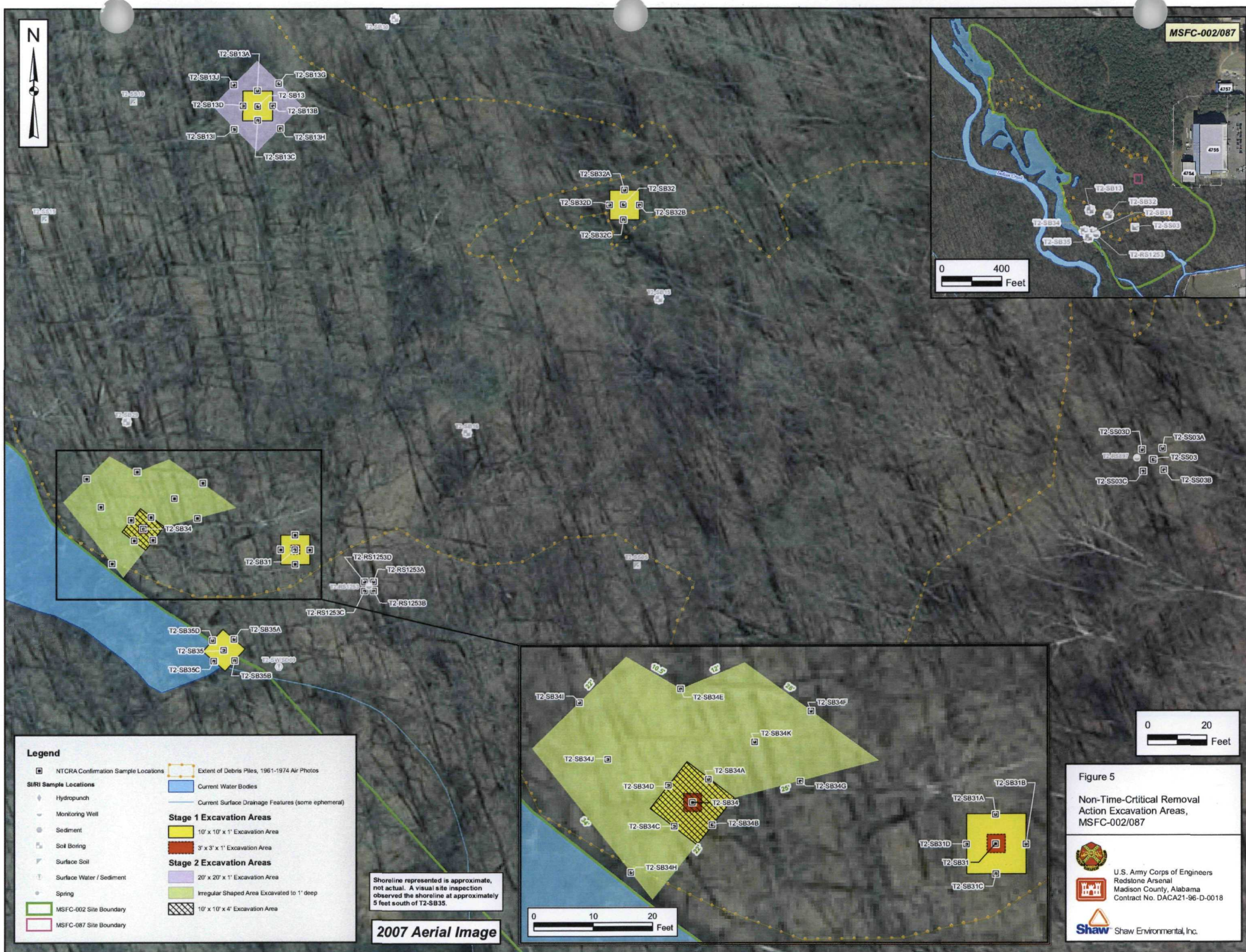
Conceptual Site Model
MSFC-002/087

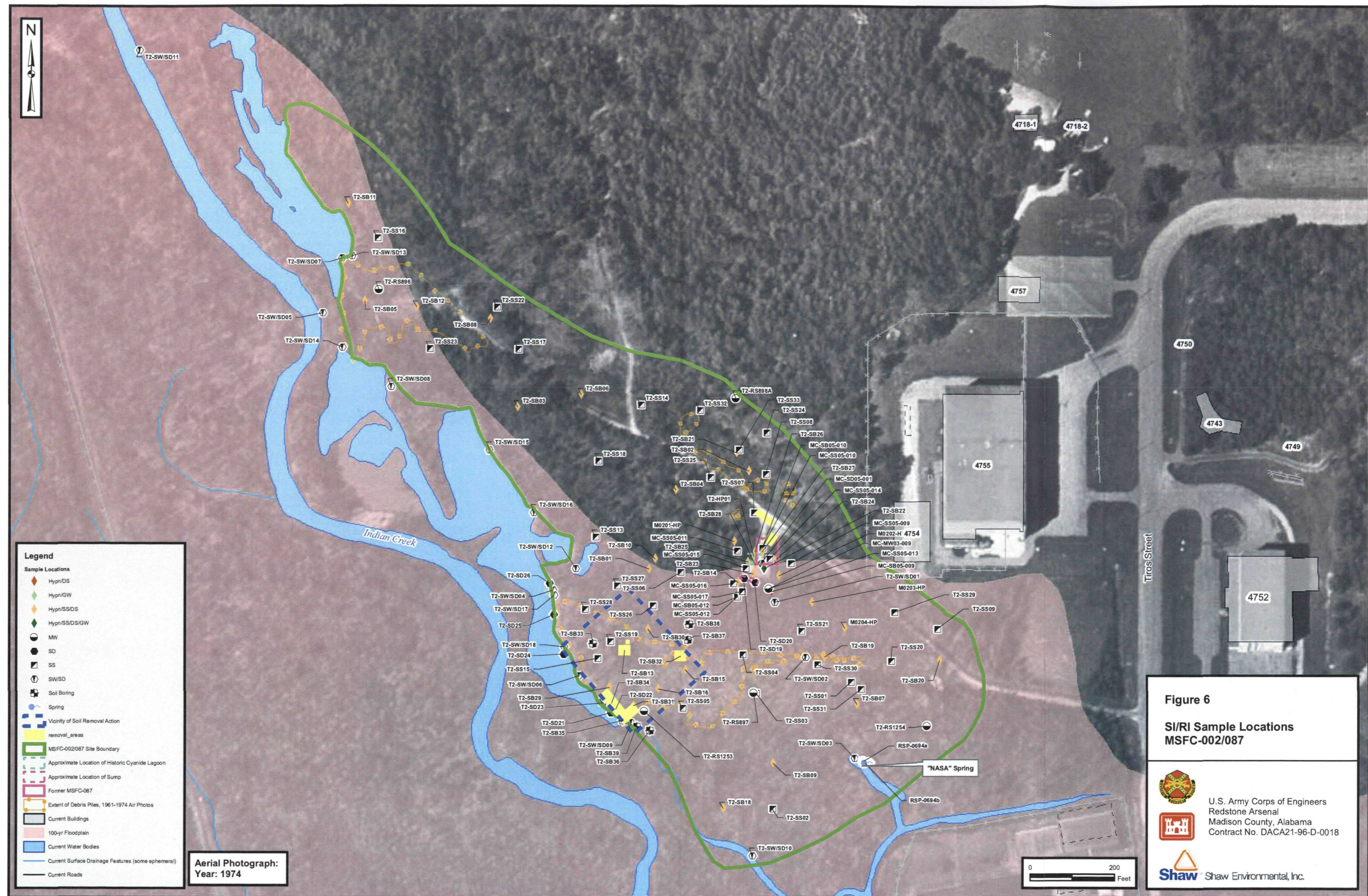


U.S. Army Corps of Engineers
Redstone Arsenal
Madison County, Alabama
Contract No. DACA21-96-D-0018



Shaw Environmental, Inc.





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APPENDIX A

GLOSSARY OF TERMS

GLOSSARY OF TERMS

Administrative Record File – The body of reports, official correspondence, and other documents that establish the official record of analysis, cleanup, and final closure of a CERCLA or RCRA site.

Background Levels – Naturally occurring concentrations of inorganic elements (metals) that are present in the environment.

Baseline Human Health Risk Assessment (BHHRA) – Analysis of the potential adverse human health effects (current or future) caused by hazardous substance release from a site in the absence of any actions to control or mitigate these releases.

Characterization – The compilation of all available data about the waste unit to determine the rate and extent of contaminant migration resulting from the waste site, and the concentration of any contaminants that may be present.

Chemicals of Concern (COC) – Where cumulative risks have been found to exceed designated risk thresholds, chemicals with risks exceeding 1×10^{-6} (or an excess lifetime cancer risk of 1 in 1,000,000) or an HI = 0.1 may be selected as COCs. These are chemicals that significantly contribute to unacceptable risks for a pathway in an exposure model for a hypothetical receptor (e.g., a child that resides on the site). Final identification of COCs may occur during a removal action or as part of the evaluations performed during the feasibility study for a site.

Chemicals of Potential Concern (COPC) – Chemicals of potential concern are chemicals found at the site at concentrations above federal and state risk-based screening levels for human health (and background screening levels for metals). Chemicals with concentrations above these levels are further evaluated in the BHHRA.

Chemicals of Potential Ecological Concern (COPEC) – Chemicals of potential ecological concern are chemicals found at the site at concentrations above ecological chemical- and media-specific generic effect levels. Chemicals with concentrations above these levels are further evaluated in the ecological risk assessment.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 1980 – CERCLA was enacted by Congress in 1980 and was amended by the Superfund Amendments and Reauthorization Act in 1986. CERCLA provides federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites and established the Superfund Trust Fund.

Contaminant Plume – A column of contamination with measurable horizontal and vertical dimensions that is suspended and moves with groundwater.

Dilution Attenuation Factor 4 (DAF₄) Soil Screening Levels (SSL) – DAF₄ SSLs are soil threshold concentrations calculated using methodology developed by EPA below which there is not a concern for migration of residual contaminants in soil to groundwater at concentrations

above MCLs or risk-based screening concentrations. Dilution attenuation factors represent the reduction in the contaminant concentrations through soil. A DAF_1 means there is no dilution or attenuation through the soil column. A high DAF value means there is a high degree of dilution or attenuation. The Army in conjunction with EPA and ADEM has determined that a DAF_4 is appropriate for initial screening for protection of groundwater from contamination in soil at Redstone Arsenal.

Exposure – Contact of an organism with a chemical or physical agent. Exposure is quantified as the amount of agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut) and available for absorption.

Groundwater – Underground water that fills pores in soil or openings in rocks to the point of saturation. Groundwater is often used as a source of drinking water via municipal or domestic wells. Groundwater that comes to the earth's surface, such as streams and springs, is considered surface water. At Redstone Arsenal, the groundwater is not a source of drinking water.

Groundwater Site – Sub-watersheds defined at Redstone Arsenal from a site-wide hydrogeologic investigation. Each groundwater site will proceed through a separate CERCLA investigation to get to closure of the site.

Interim Record of Decision (IROD) – Document prepared when a quick action is needed to protect human health and the environment or when a temporary measure to stabilize the site/and or prevent contamination migration is needed. A final ROD must follow an IROD.

Maximum Contaminant Level (MCL) – National standards for acceptable concentrations in drinking water in treatment plants producing potable water. These standards are legally enforceable standards set by the EPA under the Safe Drinking Water Act.

Operable Unit (OU) – A discrete portion of a remedial response that comprises an incremental step toward addressing site problems. It can be a geographic area and can address an environmental medium at the site (e.g., groundwater). At Redstone Arsenal, OUs are defined based on similarities in historical processes or functions which have resulted in site releases of a similar nature.

Pesticides – Substances used to prevent or control the damage by pests. The pesticide DDT was believed to have been transported to MSFC-007/087 as part of the general waste deposited in the mounds and piles.

Polynuclear Aromatic Hydrocarbons (PAH) – A group of over 100 chemicals that are formed during the incomplete burning of coal, oil and gas, or other organic substances. PAHs are common constituents of construction material found at MSFC-002/087.

Preliminary Remediation Goals (PRG) – Preliminary remediation goals combine current human health toxicity values with standard exposure factors to estimate contaminant concentrations in environmental media (soil, air, and water) that are considered by EPA to be health protective of human exposures (including sensitive groups) over a lifetime. Exceeding a

PRG suggests that further evaluation of the potential risks that may be posed by site contaminants is appropriate.

Principal Threat Waste – Source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

Proposed Plan (PP) – A legal document that provides a brief analysis of remedial alternatives under consideration for the site/operable unit and proposes the Preferred Alternative. It actively solicits public review and comment on all alternatives under consideration.

Record of Decision (ROD) – A legal document that explains to the public which remedial clean up alternative will be used at a site. The ROD is based on information and technical analysis generated during the remedial investigation, risk assessments, feasibility study, and consideration of public comments and community concerns.

Remedial Investigation (RI) – A study designed to gather data needed to determine the nature and extent of contamination at a Superfund site. The RI at Redstone Arsenal includes a baseline human health risk assessment and a screening-level ecological risk assessment.

Resource Conservation and Recovery Act (RCRA), 1976 – A Federal law that gives EPA the authority to control the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA focuses only on active and future facilities and does not address abandoned or historical sites.

Responsiveness Summary – A summary of oral and/or written comments received during the statement of basis/proposed plan comment period and includes responses to those comments. The Responsiveness Summary is a key part of the ROD, highlighting community concerns.

Screening-Level Ecological Risk Assessment (SLERA) – The initial phase of an ecological risk assessment in which conservative concentrations of site chemicals are quantitatively compared to chemical- and media-specific generic effect levels. Those chemicals selected as chemicals of potential ecological concern are further refined through quantitative comparison to chemical- and species-specific effect doses, as well as qualitative examination. Those chemicals identified as chemicals of concern may be investigated further, remediated, or left in place per the decision of the risk managers.

Site Investigation (SI) – A study designed to gather data needed to confirm the presence or absence of contamination at a Superfund site.

Soil Vapor – Air and vapor that resides in the interstitial pores between soil particles.

Solid Waste Management Unit (SWMU) – Site at which solid wastes have been placed at any time, regardless of whether the unit was intended for the management of solid or hazardous waste and from which contaminants may migrate.

Statement of Basis (SB) – A report describing the corrective measures/remedial actions being conducted pursuant to the Alabama Hazardous Waste Management Regulations, as amended.

Subsurface Soil – Soil that is 1 foot below ground surface to the water table. Only subsurface soil to 10 feet below ground surface is included in the baseline human health risk assessment.

Surface Media – The soil (surface and subsurface), soil vapor, sediment, surface water, and spring water at MSFC-002/087.

Surface Soil – Soil that is 0 to 1 feet below ground surface.

Trichloroethene (TCE) – TCE is a colorless or blue liquid with an odor similar to ether. It is man-made and does not occur naturally in the environment. TCE was once commonly used to remove oils and grease from metal parts and has been used in the dry cleaning industry.

ONIS "TREY" GLENN, III
DIRECTOR



BOB RILEY
GOVERNOR

Alabama Department of Environmental Management
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April 11, 2008

Mr. Terry Hazle, Director
Directorate of Environmental Management
DEPARTMENT OF THE ARMY
Installation Restoration Division
(AMSAM-RA-DEM-IR)
US Army Aviation and Missile Command
Building 4488
Redstone Arsenal, AL 35898

Re: **ADEM Review and Concurrence:**

Army's Responses to ADEM comments on *Draft-Final Remedial Investigation Report RSA-88, Temporary Storage Pad at Building 7625*, dated on September 2007 and *Draft-Final Remedial Investigation Report RSA-94, Solvent Degreaser Distiller at Building 7625 Operable Unit 10*, dated September 2007.
Redstone Arsenal, Madison County, Alabama
DSMOA Site No 535-223-5545
Facility ID No: AL7 210 020 742

Dear Mr. Hazle:

The Alabama Department of Environmental Management (ADEM or the Department) has reviewed the Army's subject documents listed above. The Army submitted responses to ADEM review comments regarding the subject documents on February 28, 2008. ADEM has determined all comments to be resolved. Therefore, the Department concurs with the overall content of the subject documents.

In addition, ADEM understands that the concentrations of perchlorate in the surface media are present at levels above the site-specific DAF₄ SSL limit, and the groundwater data indicates that perchlorate in the soil will continue to source the respective groundwater plume at RSA-088 unless remedial action is taken. ADEM acknowledges that the conclusions within these Draft-Final RI reports support the need for remedial action of the surface media at RSA-88 and no action for the surface media at RSA-094.

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(251) 432-6598 (Fax)

Mr. Terry Hazle
April 11, 2008
Page 2 of 2

Should you have any questions regarding this correspondence, please contact Krishna Morrisette at (334) 394-4335 or via e-mail at kmorrisette@adem.state.al.us.

Sincerely,



Stephen A. Cobb, Chief
Governmental Hazardous Waste Branch
Land Division

SAC/TPS/KMM/mal

cc: Terry de la Paz, Redstone Arsenal
Tracy Strickland, ADEM

Michelle Thornton, EPA Region IV
Farley Davis, NASA MSFC

File: Land Division/DSMOA/HW/RSA/Correspondence, 2008



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4

61 Forsyth Street
Atlanta, Georgia 30303-3104

May 5, 2008

4SD-FFB

Mr. Terry Hazle
Environmental Management Division
(IMSE-RED-PWE, Terry Hazle, Room A321a)
U.S. Army Garrison – Redstone
4488 Martin Road
Redstone Arsenal, AL 35898

Subject: Redstone Arsenal
EPA ID# AL7 210 020 742

Dear Mr. Hazle:

The U.S. Environmental Protection Agency (EPA) has received your letter dated March 24, 2008 and the Draft Final Record of Decision for Surface Media at MSFC 002/087: Inactive Abandoned Drum Disposal Site/Inactive Cyanide Lagoon, Revision 01, Operable Unit 18, Redstone Arsenal, Madison County, Alabama. EPA has reviewed the document and has found it adequate for its intended purpose. Pending resolution of any public comments that were received during the public comment period on the Proposed Plan/Statement of Basis the document may be finalized and routed for approval/concurrence.

Please contact me at 404/562-8539 or at Vaughn-wright.debbie@epa.gov, if you have any questions.

Sincerely,

Deborah A. Vaughn-Wright

Deborah A. Vaughn-Wright
Sr. Remedial Project Manager

Cc: Terry De La Paz, RSA
Richard O'Donnell, AEC
Mr. Philip Stroud, ADEM
Michael Newton, R4-OEA
Don Burton, Shaw
Kajuana Rice, ADEM